COLLEGE OF ENGINEERING CORNELL UNIVERSITY

University Microfilms
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Ann Arbor, Mich.

# the Cornell engineer

DECEMBER, 1956
VOL. 22, NO. 3
25 CENTS

**Thomas A. Beattie, class of '47,**
**speaks from experience when he says:**

# "At U. S. Steel one has a great amount of varied experiences. There is truly never a dull moment."

After receiving his B.S. in Mechanical Engineering in 1947, Mr. Beattie entered the employ of U. S. Steel as a student engineer. That was on September 22, 1947, and included service in the United States Navy from 1943 to 1946.

Mr. Beattie's progress from that date onward is typical of that of many engineering graduates who plan their future with U. S. Steel. For, within two years, we find Mr. Beattie advanced to the position of Process Engineer, Maintenance Department. Then on April 16, 1951, he was promoted to Relief Foreman, Shops, Maintenance Department. On March 1, 1952, he was made Turn Foreman, Blooming and Bar Mills, Mechanical Maintenance Department. And on January 1, 1955, he was promoted to his present post of Assistant Superintendent, Maintenance Department, of U. S. Steel's National Tube Division's National Works.

In this position, Mr. Beattie's responsibilities are numerous. They include the Service Power House and Skelp Mill area; maintenance of four blast furnaces and blast furnace auxiliaries, plus a sintering plant; maintenance of two blooming mills and soaking pits; maintenance of one bar mill; maintenance of three Bessemer converters, three open hearth furnaces, three open hearth auxiliaries, and seventy overhead cranes ranging from two to 200 tons. He supervises 680 men.

As Mr. Beattie remarks: "A steel plant includes all departments . . . every craft known to industry. In the space of three years, a U. S. Steel engineer can obtain experience that may take three times as long under different employment circumstances. One meets all types of problems and personnel. Each day is varied, certainly not dull, and yet no problem is insurmountable. Certainly, there is no possibility of getting 'into a rut' here."

Should you be interested in a challenging and rewarding career with United States Steel and feel that you can qualify, consult your college placement director for further information. Upon request, we shall be glad to send you a copy of our informative booklet, "Paths of Opportunity." Simply write to United States Steel Corporation, Personnel Division, Room 1662, 525 William Penn Place, Pittsburgh 30, Pa.

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# SOCONY MOBIL BUILDING

Control vital pipe lines
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In an area where news-making structures greet the eye on every side, the new Socony Mobil Building sets some impressive records. It is New York's biggest in 25 years. With its stainless-steel skin, it is the world's largest metal-clad building. It is the first big office building in New York to use a high-voltage wiring system, and the first to use self-service elevators exclusively.

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For plant operating engineers in every industry, as well as builders, the Jenkins Diamond trade mark is the reliable guide to lasting valve economy. Jenkins Bros., 100 Park Ave., New York 17.

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*Plumbing Contractor:* EUGENE DUKLAUER, INC.

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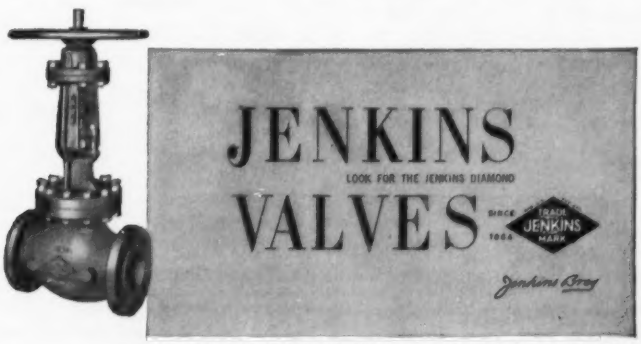


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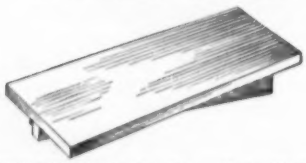

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Results from using welded steel instead of gray iron are shown in the above design comparison of a typical bracket used on modern machinery. The cast bracket costs $28.13. The welded steel bracket costs $6.49, weighs 65% less, yet is stronger and more rigid than the cast design.

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# THE CORNELL engineer

DECEMBER, 1956 VOLUME 22 NO. 3

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**COVER: Architect's Drawing of Cornell's New Civil Engineering Building.**

**Last month's cover was the drawing of the new Aeronautical Engineering wing, not the Mechanical Engineering wing as identified.**

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# CAREERS WITH BECHTEL

JAMES F. DEL CURO, *Mechanical Engineer, Power Division*

## MECHANICAL ENGINEERING

*One of a series of interviews in which Bechtel Corporation executives discuss career opportunities for college men.*

QUESTION: *As I understand it, Mr. Del Curo, the Power Division is concerned with the engineering phases of steam-electric generating plants?*

DEL CURO: That's true. Our own department is specifically concerned with the mechanical engineering phases of such plants.

QUESTION: *When the engineering graduate joins your department are his starting duties standard?*

DEL CURO: Yes. The routines are pretty well defined. We know a man learns best by actual doing, so he is put to work immediately on heat balances, line size calculations, specifications, miscellaneous and minor auxiliary equipment, instrument data sheets and information for plant data books.

QUESTION: *In other words, you sort of throw the man in and he has to learn to swim by himself?*

DEL CURO: No. He has plenty of help. He works under the direct supervision of a job engineer or the mechanical group supervisor.

QUESTION: *How long does this training phase last?*

DEL CURO: That will vary with the man, since aptitudes and desires to learn are different. The average is somewhere between a year and eighteen months.

QUESTION: *During this period he will gradually advance to more complicated equipment?*

DEL CURO: Yes. For example, after a while he will be doing original work on heat balances and system studies. He will be able to take an entire "piece" of a project and handle it on his own responsibility. He will become involved with bigger equipment and with the overall aspects of the power plant. Somewhere along the line he will likely be assigned to try his hand at piping materials, piping specifications and combined control specifications.

QUESTION: *What about the man who wants to specialize?*

DEL CURO: If, for example, a man shows a particular interest in steam turbines, instrumentation or control, and demonstrates a special aptitude for one of them, he will often be called on to work on that specialty, without being confined to it exclusively. Thus we encourage specialization, even during the training period, but also make sure that the young man gets overall experience through work in all phases of mechanical engineering.

QUESTION: *What about field experience?*

DEL CURO: That is, of course, highly desirable from his standpoint and ours. We make every effort to assign the young engineer to field work as soon as possible.

QUESTION: *What will he do in the field?*

DEL CURO: When we are building a power plant we try to get the young engineer on the job five or six months before the scheduled start up of the plant. He will actually help the chief start up engineer by writing up procedures, planning the hydraulic washing to steam lines, working on the start up of each piece of the equipment, checking out controls, etc.

He will also handle paper work such as filling out the data sheets that are later turned over to the plant operators to aid them in running the plant. By the time the turbine is rolled and the job ends, the young engineer has been able to see the end result of all the engineering work he and others have done back in the office.

QUESTION: *Are there any other types of field assignments?*

DEL CURO: If the young engineer desires such experience, he is sometimes used in the construction department if that group is shorthanded.

*Bechtel Corporation (and its Bechtel foreign subsidiaries) designs, engineers and constructs petroleum refineries, petrochemical and chemical plants; thermal, hydro and nuclear electric generating plants; pipelines for oil and natural gas transmission. Its large and diversified engineering organization offers opportunities for careers in many branches and specialties of engineering—Mechanical . . . Electrical . . . Structural . . . Chemical . . . Hydraulic.*

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*Vice President, Industrial Relations*
*220 Bush Street, San Francisco 4, Calif.*

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If you expect to be a graduate engineer shortly, all this can be most important to you. Sikorsky Aircraft, the company that pioneered helicopters, is moving into high gear . . . going all out to keep pace with ever-increasing military and commercial requirements. Quite naturally, the world looks to Sikorsky to design and build the helicopters of tomorrow. And for the creative engineering, for the imagination, for the technical abilities that the future will demand . . . Sikorsky Aircraft looks to *you*.

We would welcome the opportunity to give you a more complete picture of our company . . . and to see if there is a place in that picture for you. The next step is yours. Take that step and write to Mr. Richard Auten, Personnel Department.

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# DREAMS

*First Reverie* It's almost Christmas and no decision about a job after OPERATION GRADUATE—only five months away.

*Second Reverie* Why can't Mary and I settle this thing during Christmas vacation — the last Christmas vacation too — next year it's only a day off.

*Third Reverie* Wonder if she would buy New Jersey as a place to live. Working for Public Service has its appeal. Its service area has everything for a good life. Urban advantages in suburban communities — culture recreation, and all that make life pleasant.

HEAR! HEAR! And we say to you, Big Boy, that your dreams are not idle ones. Grasp them. Working for Public Service Electric and Gas Company is definitely good — and Mary will love New Jersey.

Sometime soon, a Public Service representative will be on your Campus. Look him up and get the low-down on the Company's job opportunities. In the meantime, write for literature to show Mary during the holidays — use the coupon.

Public Service Electric and Gas Company,
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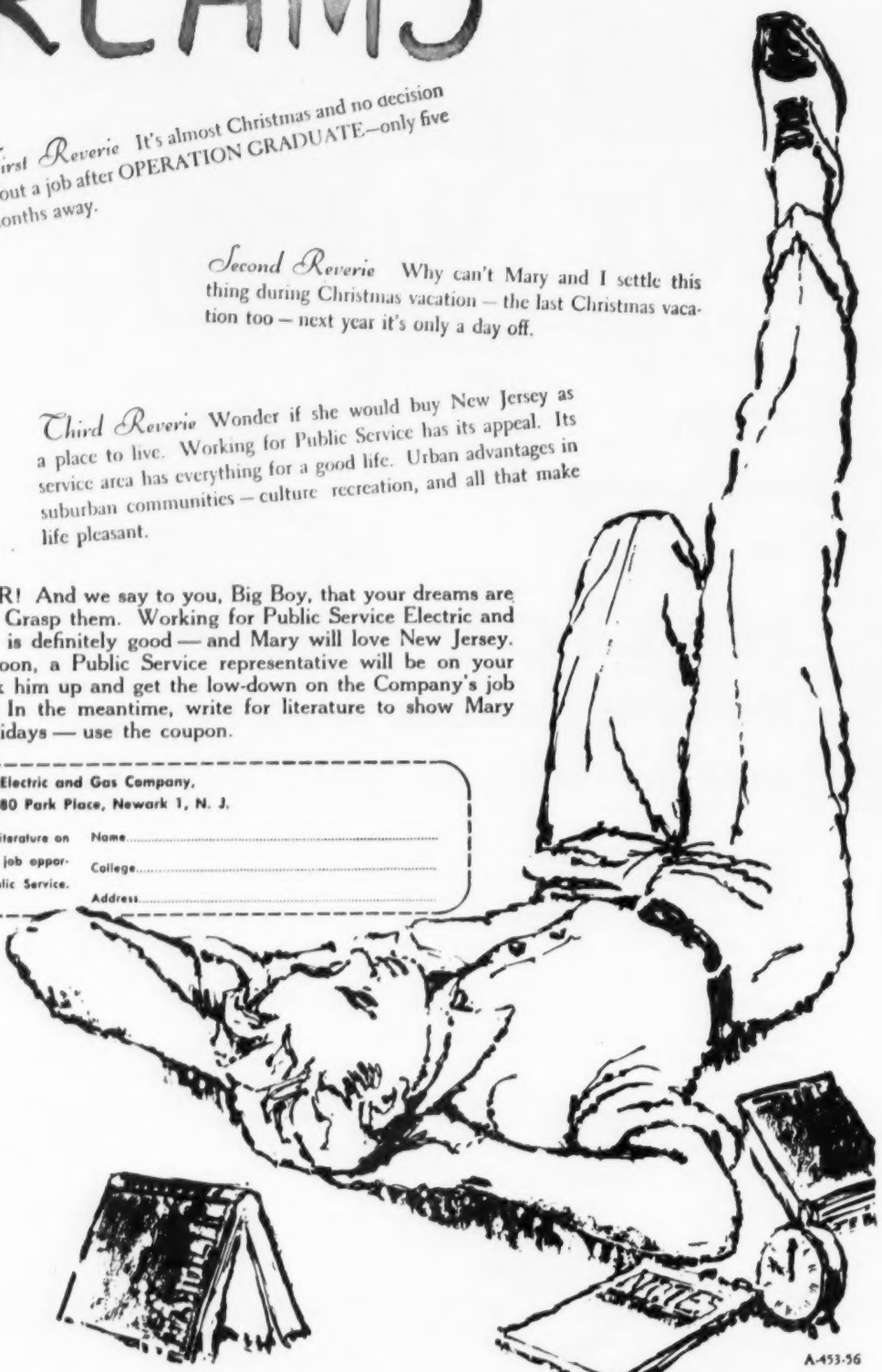
Please send me literature on New Jersey and job opportunities with Public Service.

Name.....
College.....
Address.....



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# *YOUR FUTURE—Chemistry and Koppers?*

IN an age when most frontiers are shrinking, there is one that is constantly growing—the frontier of the chemist.

This frontier has been pushed slowly back ever since the days of the pioneer 18th and 19th Century chemists. Their theories, proved in laboratories, were made useful by the mechanical genius of engineers such as Heinrich Koppers, designer of the modern chemical recovery coke oven. These early scientists laid the foundation for the diversified chemical industry that has grown so rapidly in the 20th Century.

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If you would like to know more about a future in chemistry or engineering with Koppers, contact your College Placement Director. Or write Industrial Relations Manager, Koppers Company, Inc., Koppers Building, Pittsburgh 19, Pennsylvania.

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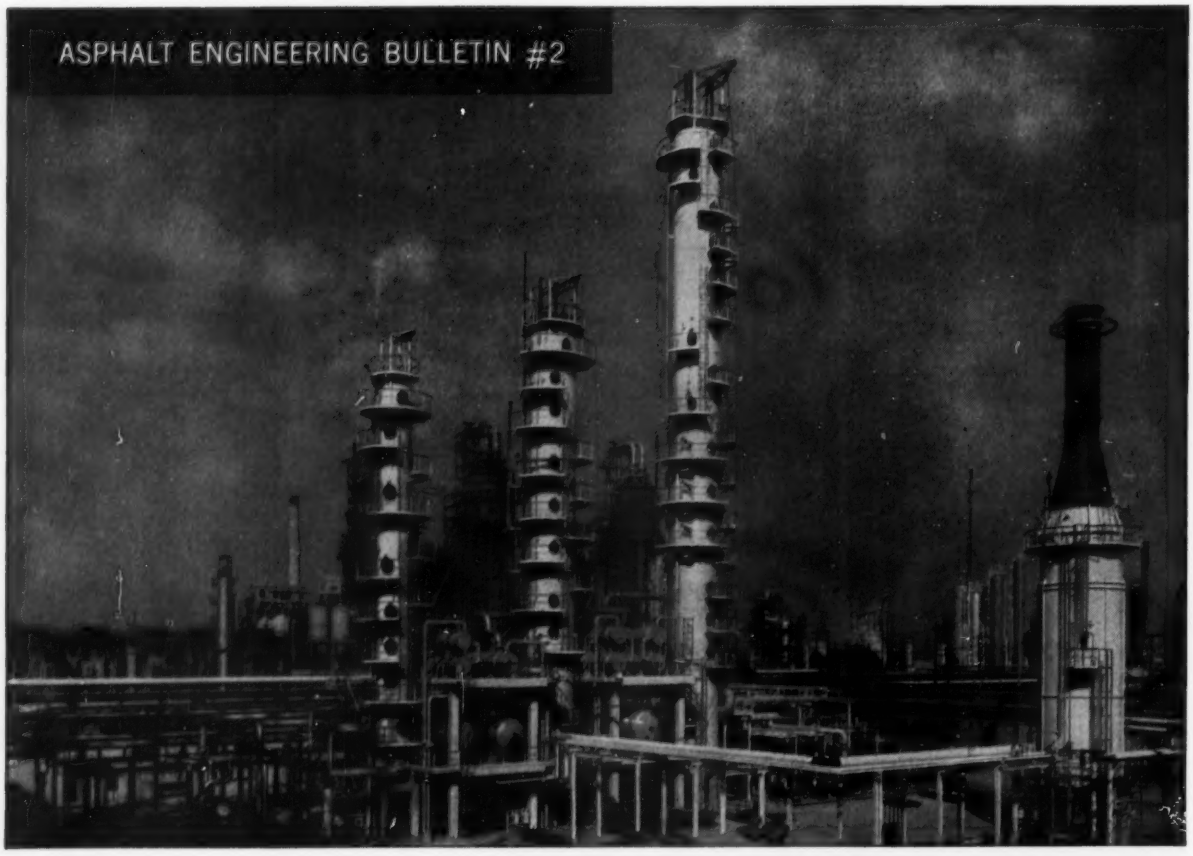


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"ASPHALT" denotes a class of material produced from crude petroleum . . . it is inherently durable, waterproof and adhesive.

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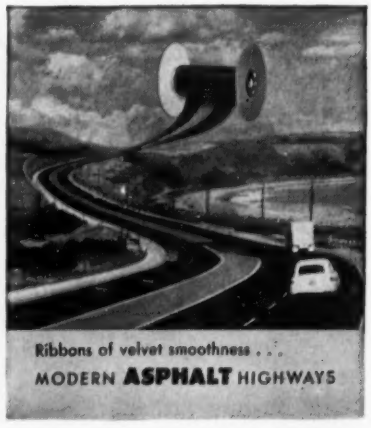
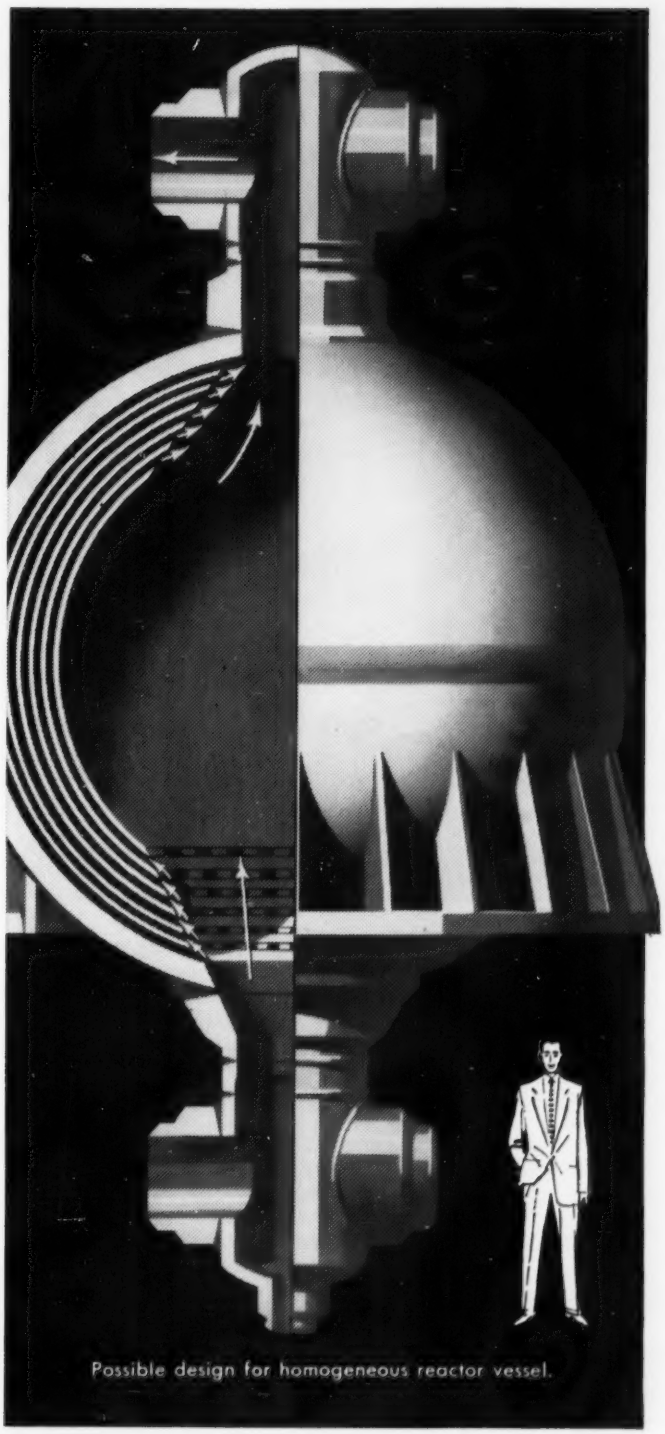



**THE ASPHALT INSTITUTE,** Asphalt Institute Building, College Park, Maryland

*Building the first large liquid-fuel reactor for a utility power plant.*

# . . . A PROBLEM IN ATOMIC POWER



Possible design for homogeneous reactor vessel.

The first large homogeneous reactor for a utility power plant is now being designed by Westinghouse engineers and scientists, in partnership with the Pennsylvania Power and Light Company, for whom the plant will be built. The plant will have a capacity of 150,000 kw.

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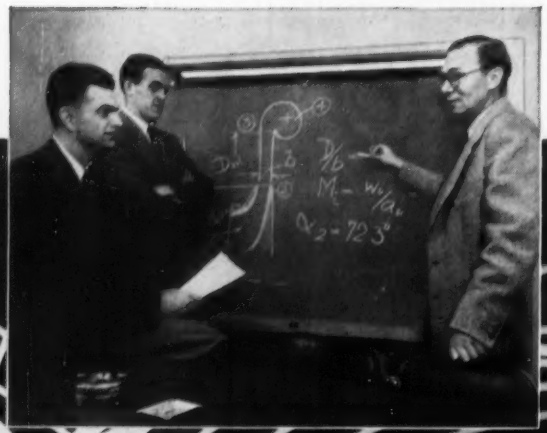
# To the engineer who intends to blaze *new* trails...



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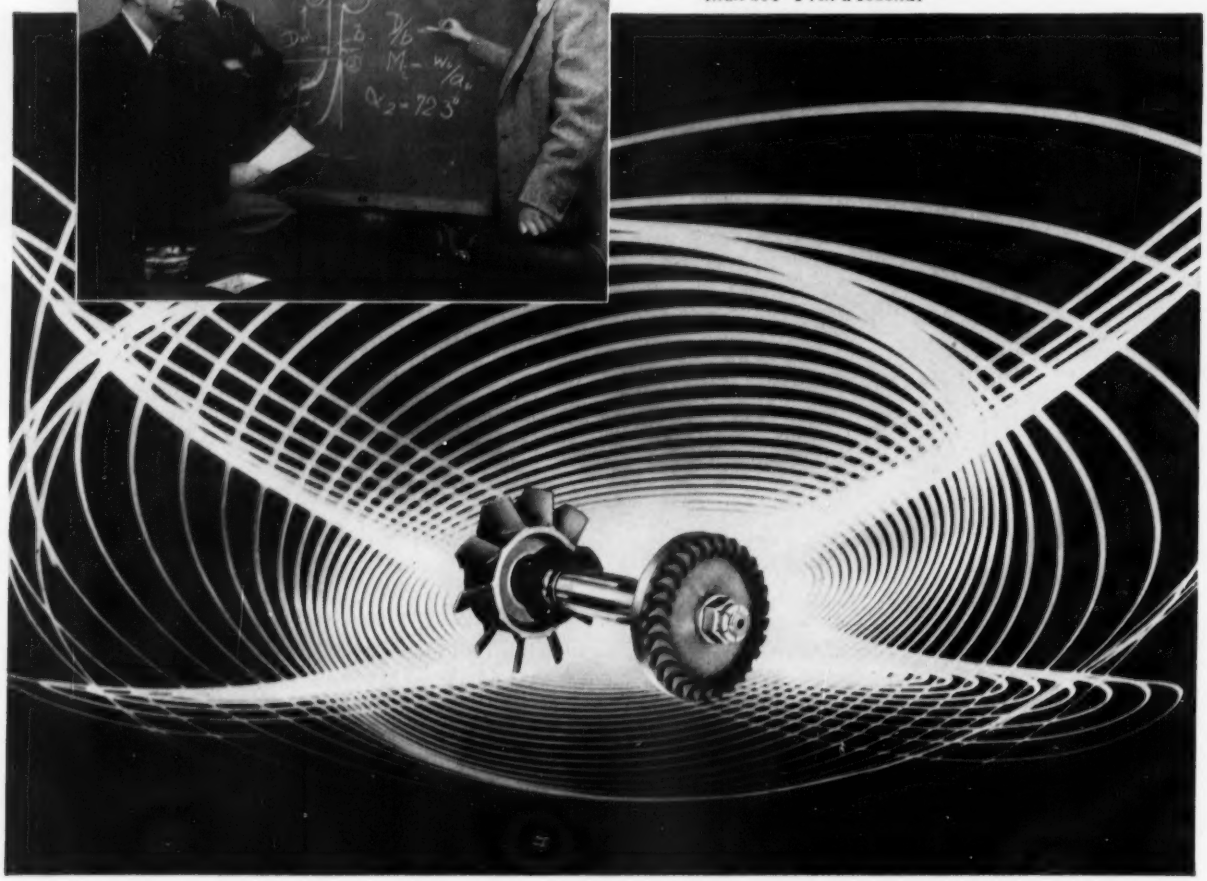

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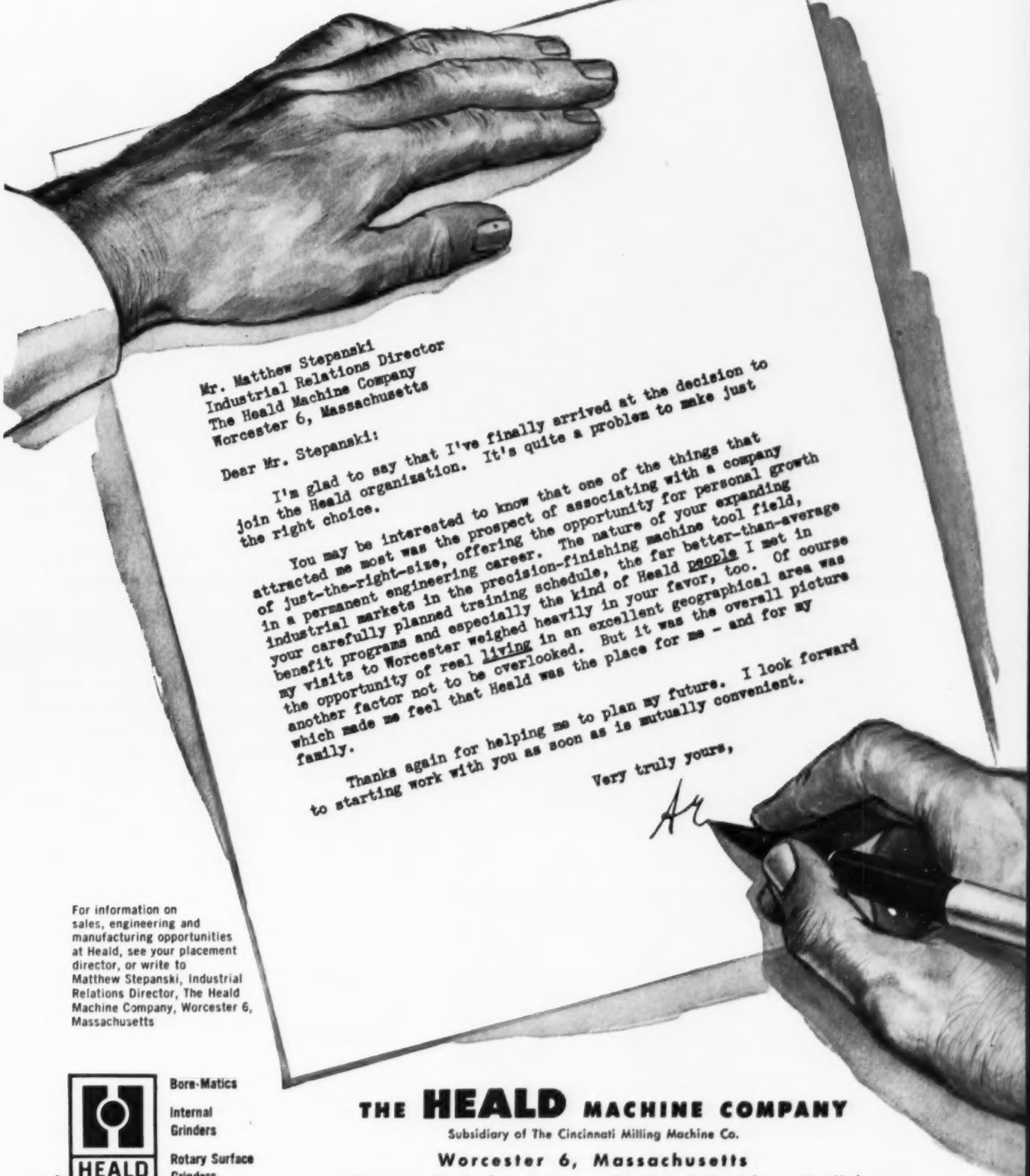
## A DECISION-MAKING LETTER

# THAT COULD BE VERY TRULY YOURS



Mr. Matthew Stepanski
Industrial Relations Director
The Heald Machine Company
Worcester 6, Massachusetts

Dear Mr. Stepanski:

I'm glad to say that I've finally arrived at the decision to join the Heald organization. It's quite a problem to make just the right choice.

You may be interested to know that one of the things that attracted me most was the prospect of associating with a company of just-the-right-size, offering the opportunity for personal growth in a permanent engineering career. The nature of your expanding industrial markets in the precision-finishing machine tool field, your carefully planned training schedule, the far better-than-average benefit programs and especially the kind of Heald people I met in my visits to Worcester weighed heavily in your favor, too. Of course the opportunity of real living in an excellent geographical area was another factor not to be overlooked. But it was the overall picture which made me feel that Heald was the place for me - and for my family.

Thanks again for helping me to plan my future. I look forward to starting work with you as soon as is mutually convenient.

Very truly yours,

For information on sales, engineering and manufacturing opportunities at Heald, see your placement director, or write to Matthew Stepanski, Industrial Relations Director, The Heald Machine Company, Worcester 6, Massachusetts

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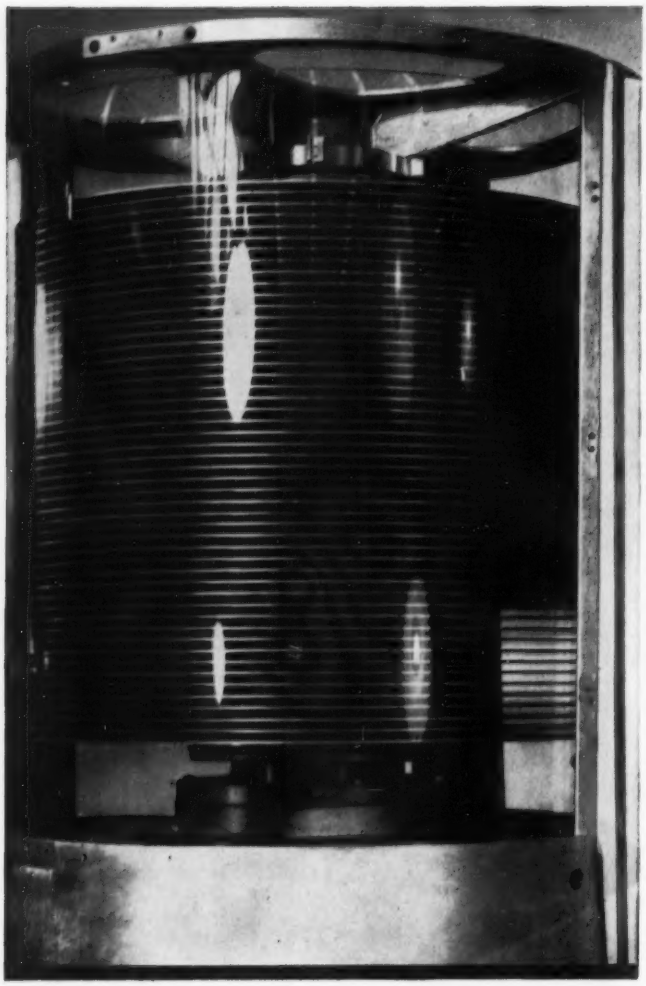

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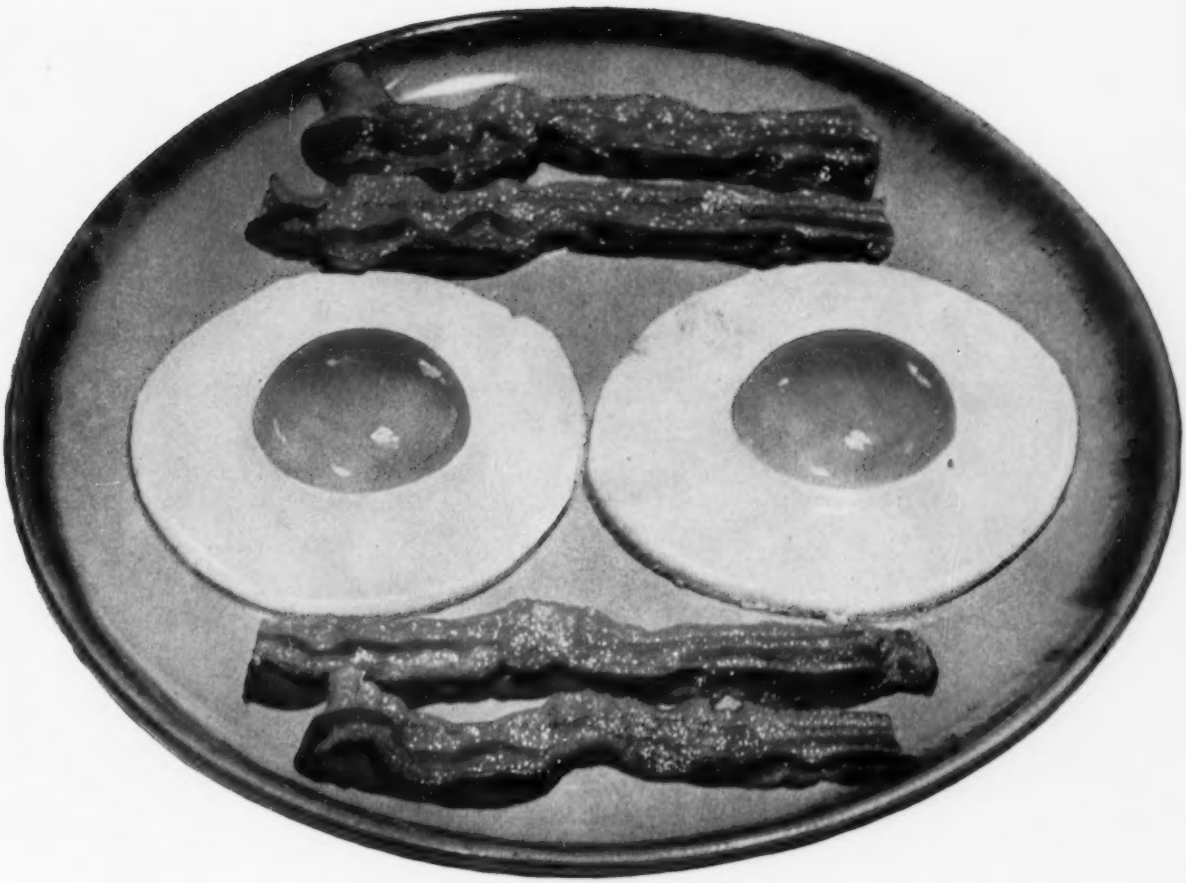

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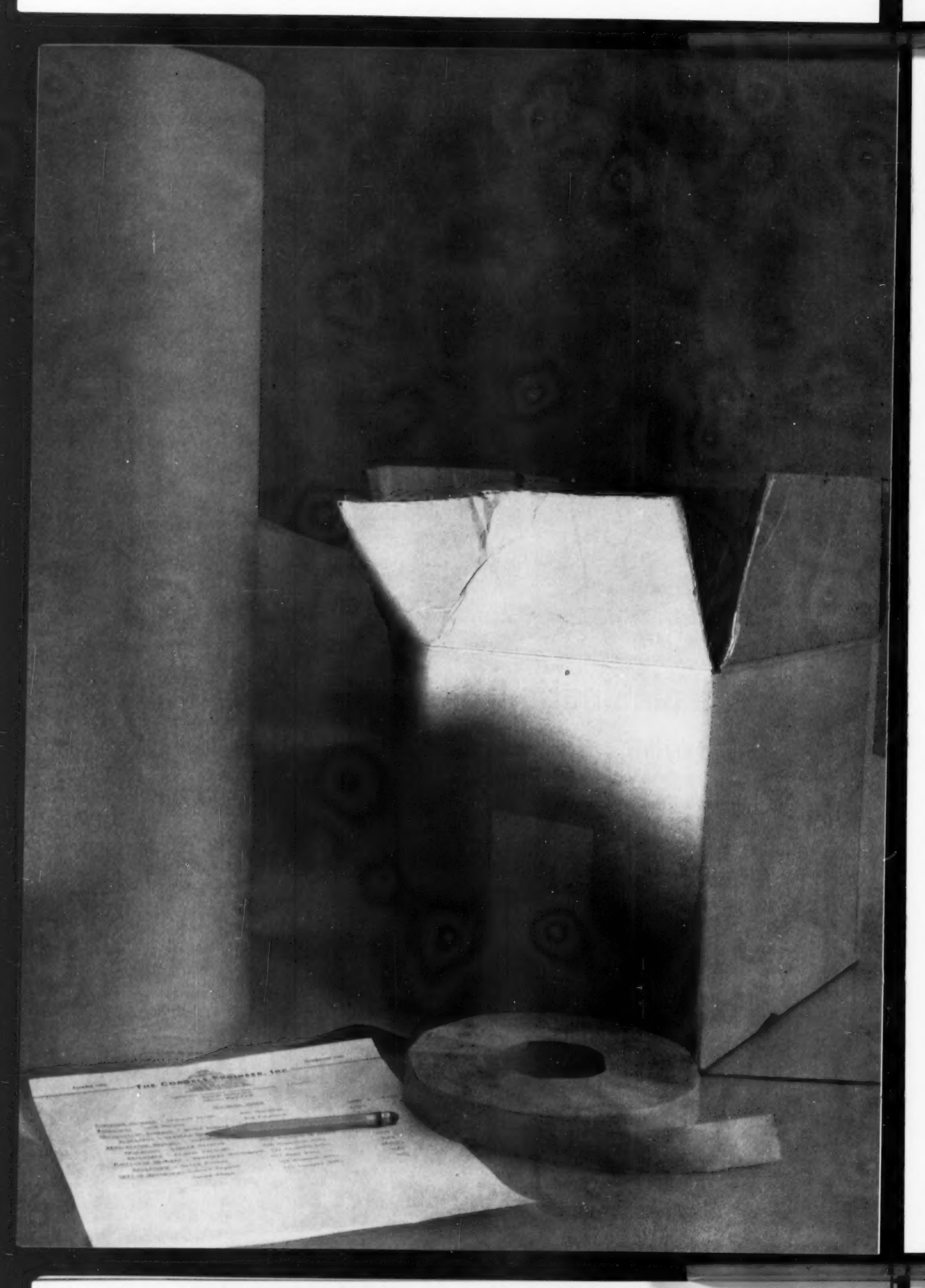


# THE CORRUGATED CARTON—
## CARGO CARRIER OF INDUSTRY

by
Alan S. Rosenthal, EE '60

All industries are confronted with the problem of transporting their product to a retail store where it can be sold to the consumer. Those mass-producers who make small items must find a container in which they can ship many at a time compactly and safely. Since World War II, more and more concerns have come to use the corrugated carton as the container for their products.

Because of its inexpensiveness, light weight, and relative strength, the demand for the corrugated box has increased enormously in recent years. These containers are called upon today to carry any item from a badminton racket to a lamp. The manufacture of a corrugated carton often proves to be a more interesting and difficult process than the production of its contents.

### The Raw Material

The life-blood of the corrugated box industry is the paperboard from which the cartons are made. This paperboard must be selected with utmost care in order for the manufacturer to be sure that he can produce the highest quality product at the lowest possible price. The final quality of the carton will be largely determined by the type of paperboard used.

The types of paperboard used in this industry are constantly changing. Chemical discoveries make possible the production of a less expensive product having the same or better properties than its more costly counterpart. The most common type of paperboard used today is known as "Kraft." Derived from the Swedish word meaning "strong," Kraft is the strongest form of pulp known. Recent chemical developments have made possible the substitution of a semi-chemical fibre for the center, corrugated sheet while Kraft paperboard is used for the flat top and bottom sheets. The semi-chemical fibre was found to be less expensive while still giving the sheet the needed strength.

Most corrugated box concerns keep at least a month's supply of paperboard on hand. This supply may amount to many thousands of tons of stock. Since rolls of stock weigh from one to two tons, the storage and handling of the rolls present a difficult engineering problem. At one time it was necessary to store the paperboard indoors, but chemical improvements in paper quality have made it possible for the rolls to be stored outside without affecting their quality. Rolls of paperboard are either stored on end and handled by overhead cranes or piled on their sides in a nested style and brought to the corrugator by lift trucks.

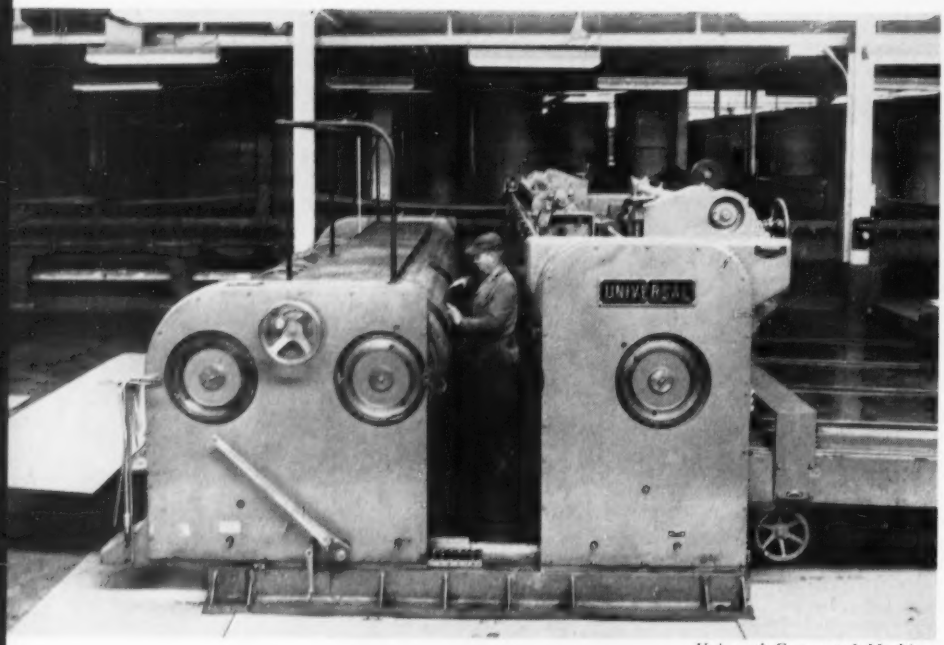
### The Corrugating Process

If the paperboard is the lifeblood of the industry, the corrugating machine is the industry's heart. The corrugator is by far the most expensive, and probably most important, single piece of equipment in a box plant. It is composed of a number of virtually separate elements. Each of its parts is a precision machine which must be perfectly integrated with every other part of the corrugator.

The first step in the production of a corrugated sheet is the shafting of one of the huge rolls of paperboard and the threading of the paperboard into the corrugator. This step is a difficult one because of the tremendous weight of each roll; moreover, each plant aims for continuous operation of the machine. In order to get a new roll into position many different methods are employed. Often the roll is put in place by a truck or dolly, which, with the aid of manually propelled reach-arms, bring the roll into the shaft sockets.

After the roll has been threaded, the paper goes through the first machine on the long corrugator. Here the sheet is preheated and showered with steam. It is then compelled to flow back and forth between the corrugated teeth of the machine until flutes are formed which are nested in a corrugating roller. On this roller the fluted sheet meets the "liner," to which it is glued. The "liner" is nothing more than a flat sheet of paperboard which has been unwound from another roll and has been showered and preheated but not fluted. The fluted sheet and liner glued together are commonly known as the "single face liner."

The completed single face liner travels over an inclined conveyor where it is permitted to fall in folds onto an overhead bridge conveyor which moves slowly toward the "double backer." While traveling




Universal Corrugated Machines

**Setting up a large printer-slotter for operation.**

on the conveyor, the single face liner loses a good deal of the heat and moisture that has been trapped in it. When it reaches the end of the overhead conveyor, it goes through the "double backer." This piece of equipment partially reheats the single face liner while it preheats, steams, and glues another liner to it, completing the corrugated sheet. For a stronger product, another single face liner may be glued to this sheet, giving a "double walled" sheet.

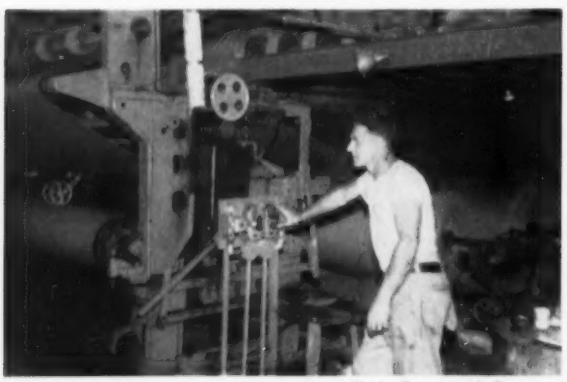
The heating-joining operation just described must be carefully controlled. The paper board must have been treated with a carefully measured amount of steam in order for it to have the proper texture when it is corrugated and joined to the liner. The type of adhesive used for the actual joining has undergone many changes because of new scientific knowledge. The adhesive employed is a very important factor since the fastening time largely determines the number of feet of board that can come off the corrugator per minute. The two most commonly used adhesives are composed of either sodium silicate or starch. Each has its own advantages and disadvantages with respect to the amount of steam required, the amount of warping which will result in the completed board, and the conditions through which the sheets can hold together. The joining process is, at best, a difficult one because the adhesive must be continuously circulated and kept at certain temperatures for best results.

After the three layers of paperboard have been fastened together, they are dried and cooled in the double backer, and a continuous length of corrugated board emerges. This board must be cut and scored according to the size of the box to be cut from it. The cutting and scoring is not too difficult a mechanical operation. Knives cut the sheet to the proper length and width while creasers make the proper horizontal scores so that the flaps of the box can be bent.

The most difficult part of the operation is the planning that is involved. The sheets must be cut so that there is a minimum of waste and a minimum of readjusting of the knives. Many corrugators are so constructed that they can deliver two different size sheets at once. This "double cut-off" makes planning for runs more difficult, but it helps the manufacturer to get the maximum amount of footage from his paperboard.

The number of feet per minute that a corrugator can produce is largely determined by the speed with which the paperboard can be fluted and joined to the liners. These processes require a large amount of heat which, if not available, will slow the corrugator accordingly. When operating at peak efficiency, the corrugator can produce a sheet, cut and scored, at the rate of 650 feet per minute.

After the corrugated sheets are taken from the corrugator, they must undergo several processes before they are ready to be assembled into completed cartons. These steps



Kraft Corrugated Container

**The large rolls of paper receive the familiar flutes in the single-facer.**

Kraft Corrugated Container

**It requires three workmen to operate this hand-stitching machine. Because it is made up of two pieces, this carton could not have been stitched automatically.**

of their production include slitting, printing, slotting, and taping or stitching.

### Slitting, Printing, and Slotting

When a carton has been scored on the corrugator in one direction and needs only to have vertical slots cut in it, it can go directly to the printer-slotter to be completed. If, however, a change in the location of the knives on the corrugator is not practical or not possible, it must first be put through a separate slitting machine.

A slitting machine is nothing more than a number of rotating knives which run on a shaft a small distance above a table. The sheets that are taken from the corrugator are hand fed into the slitter, and the machine cuts and scores the sheet where necessary. The sheet is then sent through a press where any name or slogan is printed on it, and it is cut down to the exact size desired.

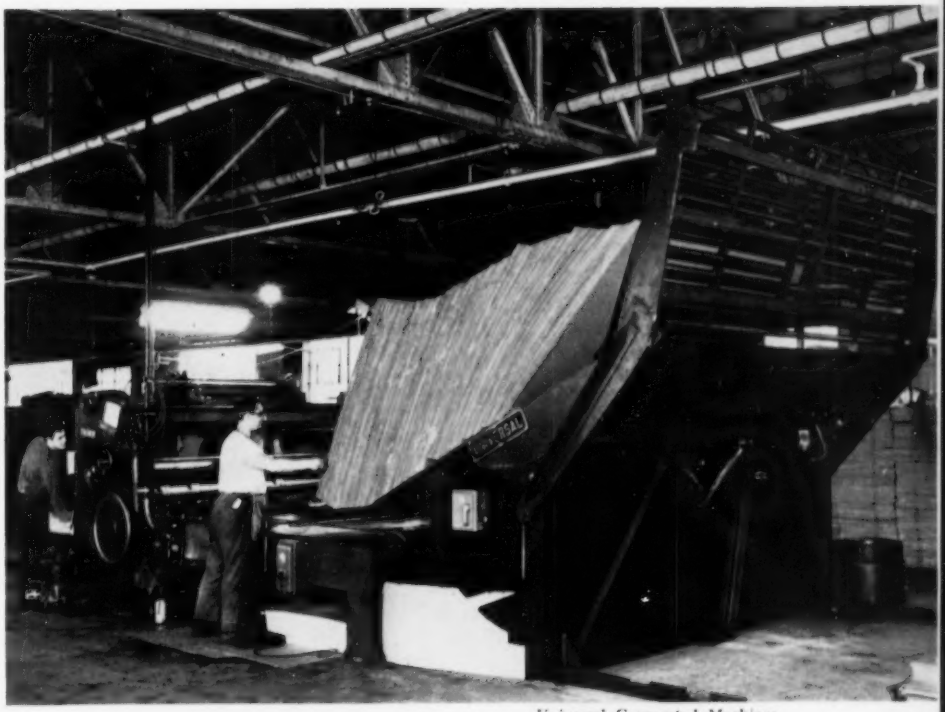
Many sheets can go directly from the corrugator to the press, or "printer-slotter." This machine embodies precision elements which provide means for printing, creasing, and slotting the sheet without being cumbersome or awkward to use. Most printer-slotters are hopper fed. The sheets are placed in a hopper and are picked off the bottom of the pile and pushed by a kicker into a pair of pull rolls that bring the sheet under the printing cylinders. After the sheet has been printed, it is conveyed to the slotting and creasing cylinders and finally deposited on a take-off table.

The printer-slotter can make cuts only in a direction parallel to the corrugations. If a large box needs to have slots cut in it (usually from the corners), it must be hand fed into an "up-and-down" or "eccentric" slotter. This is a machine in which the cutting knives are hinged to a table, receiving their power from an eccentric shaft. When the large corrugated sheet is slid under the knives, they close with a chewing action; thus cutting the sheet without crushing the corrugations.

### Finishing Operations

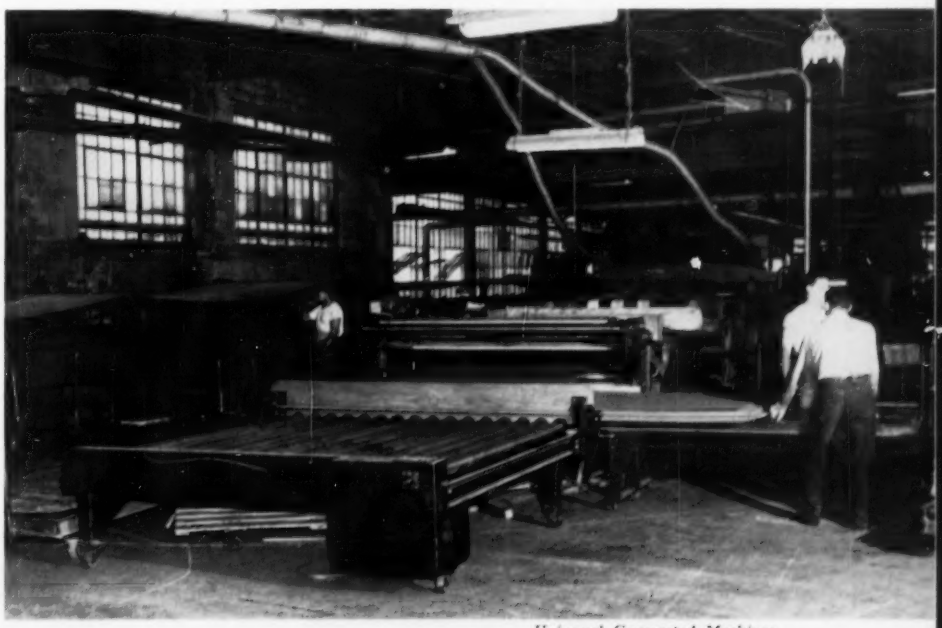
When a sheet comes out of the printer-slotter, it usually goes directly to the taper or stitcher. These machines join the open edge of the carton so that it is collapsible, occupying little space when shipped to the factories of the purchaser where it can be easily assembled. There is still much debate about the relative merits of tape and stitches. Although tape manufacturers insist that their product makes as sturdy a carton as a stitched one, companies who plan to ship unusually heavy items in their cartons prefer to have them stitched.

The stitching and taping processes can often be slow and tedious. At present there are many machines which fold the completed sheets for stitching or taping, but many sheets are too large to be



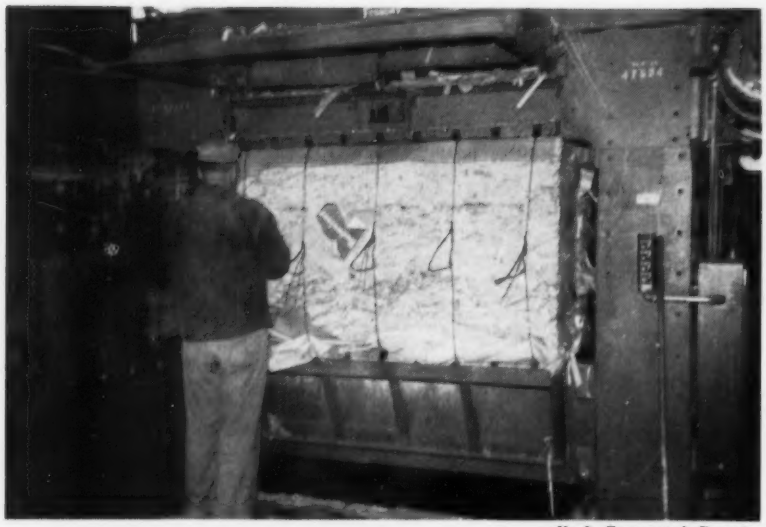
Universal Corrugated Machines

**A comparatively recent development in the industry is the automatic printer-slotter feeder. The model shown here is one of the largest of its kind.**



Universal Corrugated Machines

**Having been processed on the corrugator, the completed sheets are removed from the automatic take-off table and stacked.**



Kraft Corrugated Container

**A bale, fully compressed and wired, is ready to be sold for scrap.**

folded by machines and, consequently, must be folded by hand. In the automatic stitchers or tapers the sheets are piled in a hopper from which a push bar impels the bottom sheet into a folder. Here two metal plates fold the edges over so that the tape or metal stitches can be applied.

The stitching process, itself, involves four steps: feeding the wire, cutting it off, forming the staple, and driving and clinching it. The methods employed to carry through these steps vary widely with different types of stitching heads. In the automatic stitchers, the corrugated box is driven under several stitching heads. These heads act simultaneously, driving as many wire staples into the box as necessary. When a box is too large to be folded in the fully automatic stitching machine, a workman must fold each sheet and feed it into the machine where stitching heads do the work in a manner similar to that of the fully automatic machines. In order to facilitate the feeding process, many factories provide the workman who feeds the machine with an elevating platform which can be raised as the pile of sheets decreases.

Extremely large boxes such as those used to protect furniture must be stitched in a different manner. These type boxes are so large that they must be formed from two separate corrugated sheets. The sheets are held by several workmen and fed into a hand stitcher. This stitching machine has only one stitching head held at the end of an arm. The workman pushes the sheets under the head and steps on a treadle in order to produce a stitch at the necessary points.

Unlike the stitching machines, there are only two types of tapers, comparable to the first two stitchers mentioned. These two machines prove adequate even for multiple-piece boxes. Taping machines are fed in the same manner as stitchers. If the box is small enough, it is placed in a hopper and machine folded. When it is a larger box, or one made up of two corrugated sheets, it must be fed by a workman.

The tape, usually two inches wide, comes on rolls generally 24 inches in diameter. It is easily placed on a holder from which it is unwound at constant speed. The tape then goes through a tension device, over a water wheel, and finally to a feeding ratchet. The ratchet, activated by a device timed by push bars, is responsible for laying the tape on every box at exactly the right spot. A similar timing device operates a knife which cuts the tape to the specified length. For sidewise tape adjustment, the hopper is moved.

After leaving the taping head, the completed carton travels along a belt provided with hold-down springs and rollers to produce pressure on the tape. The length of the belt and the speed of the taper is predetermined so that enough pressure is exerted long enough to allow the bond to set between tape and box. This pressure area also serves to iron out any wrinkles that may have developed. The hand-fed taper operates in the same manner without the time and labor saving feeding and folding mechanisms. After the boxes leave the stitcher or taper, they are tied in bundles and shipped to the various industries, ready to be filled with an infinite variety of merchandise.

### Allied Corrugated Products

Throughout the production of the corrugated container, there is,

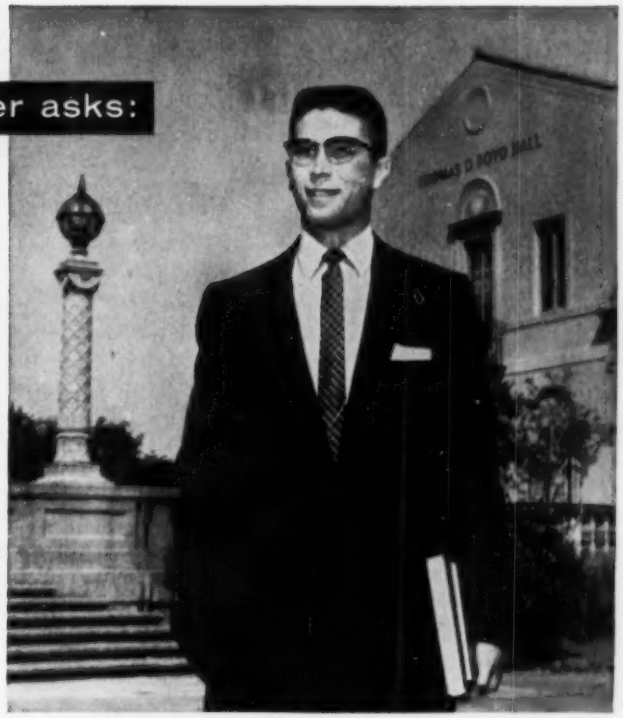
*(Continued on page 65)*

Kraft Corrugated Container

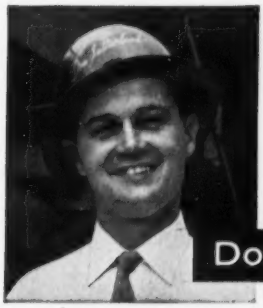
**A motor truck is used in this plant to remove the rolls of paperboard from their nested stacks.**

Oran Ritter asks:

# Does Du Pont hire men who have definite military commitments?



**Oran A. Ritter, Jr.,** expects to receive his B.S. in chemical engineering from Louisiana State University in June 1957. He's now editor-in-chief of the "L.S.U. Engineer," local president of Tau Beta Pi, and senior member of the Honor Council of his university. Oran's question is on the minds of many men planning a technical career.



Don Sutherland answers:

**Donald G. Sutherland** graduated from Virginia Polytechnic Institute in 1953 with an M.S. degree in chemical engineering and an R.O.T.C. commission. He was hired by Du Pont's plant at Victoria, Texas. After two years in the service, Don returned to his career in engineering, and is now doing plant-assistance work in the technical section at Victoria.

YES, Oran, we certainly do! We've employed quite a number of college graduates with definite military commitments, even when we knew they could work no more than a few weeks before reporting for duty. Take my own case. I was hired in November of 1953 and worked for only four weeks before leaving for the Army. Two years later I returned to Du Pont.

You see, we're primarily interested in men on a long-range basis. The fact that they're temporarily unavailable, for a good reason like military service, isn't any bar to their being considered for employment. After working only one day, an employee is guaranteed full re-employment rights—that's the law. And if a man works for Du Pont a full year before entering the service for two or more years, he receives an extra two months' salary. If he goes into the service for six months, he's paid a half month's salary. When he's entitled to a vacation but doesn't have time to take it before leaving, Du Pont gives him equivalent pay instead.

Even if present employment is impossible, Oran, we definitely recommend your talking with Du Pont's representatives as well as those of other companies. The very least you'll gain will be valuable background and some contacts of real benefit to you when you leave military service.

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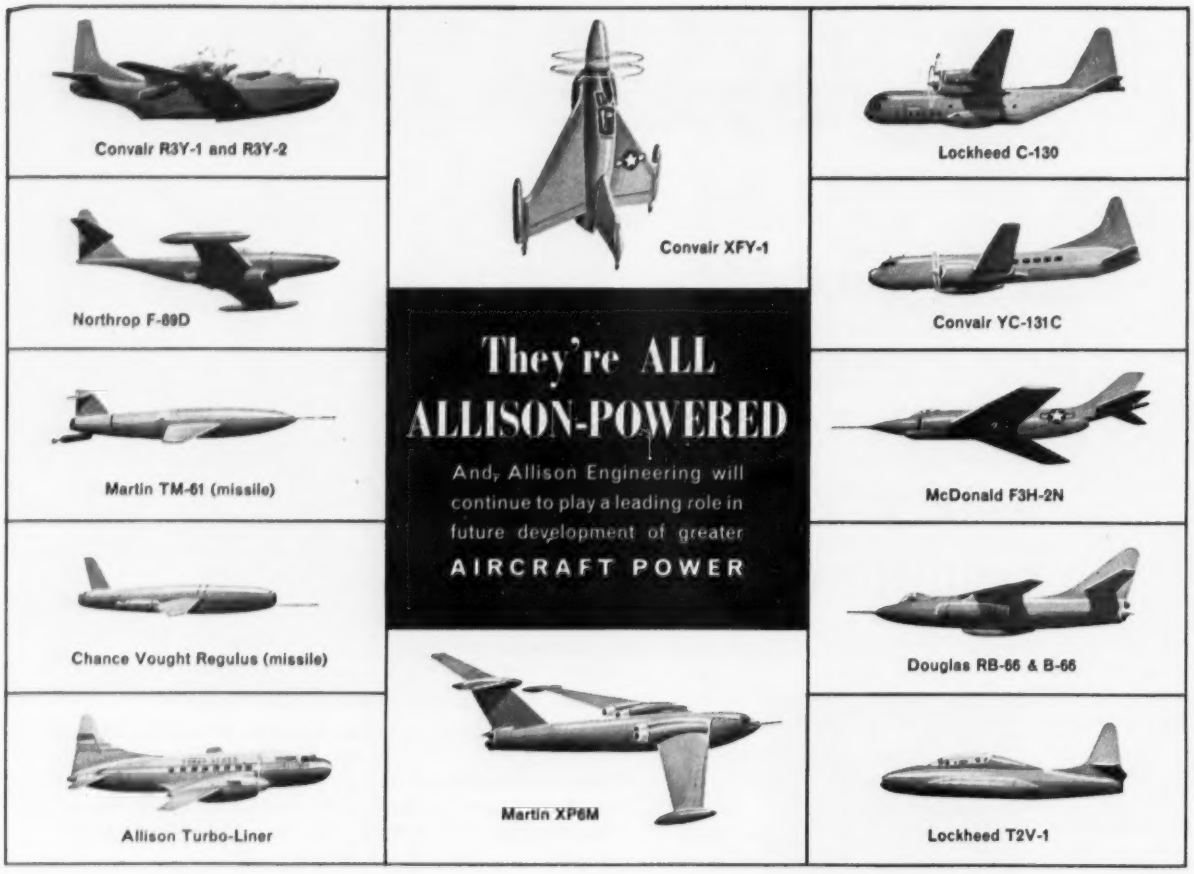


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# LOW TEMPERATURE EXPERIMENTS AT CORNELL

by

Susan Moore, EE '60 and William B. Easton, EP '61

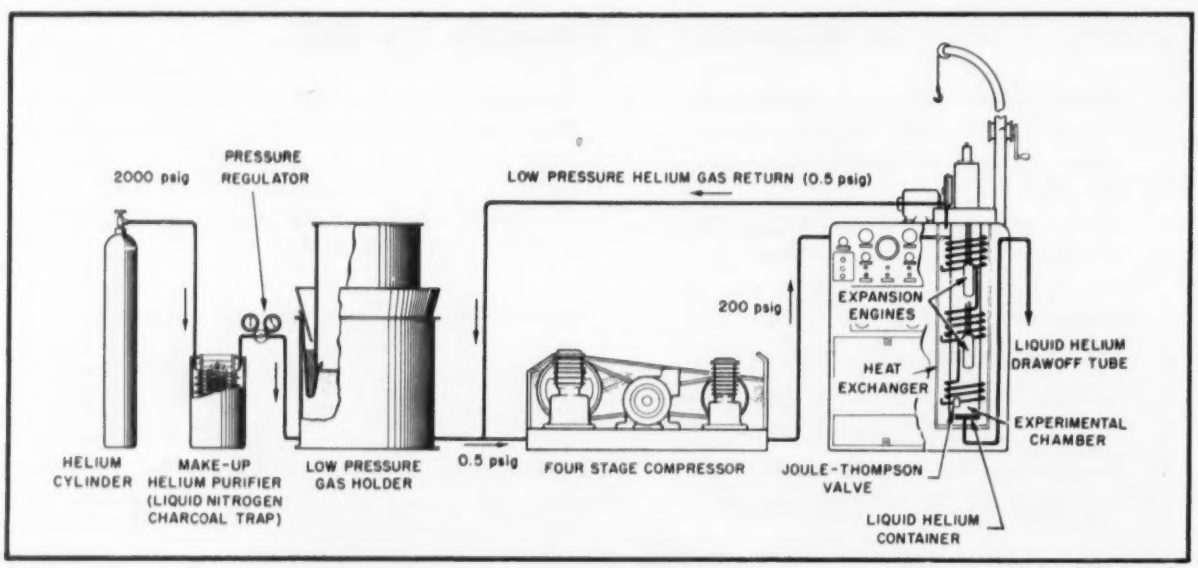
*"There was a young man named Dewar*
*Who was very much smarter than you are,*
*For none of you asses*
*Can liquefy gasses."*

This inscription appears on the door of the unimpressive brick building behind Rockefeller Hall which houses the Cornell Cryogenics Laboratory, where many interesting experiments are carried out at temperatures approaching absolute zero.

The major piece of equipment in the lab is the cryostat, a device for liquefying helium, and maintaining temperatures to within about four degrees of absolute zero. The machine, which was developed just prior to the Second World War by Professor S. C. Collins of M.I.T., is composed of several separate units—a compressor, a cabinet, and a gasometer—located in different parts of the lab.

The helium gas, which arrives in large cylinders, is first purified by freezing out impurities with liquid nitrogen. The gas is then compressed to a pressure of 225 pounds per square inch, and the heat of compression is removed by cooling with water. The compressed helium is then cooled by making it do work against the pistons of two expansion engines in the cryostat cabinet. The cooled gas is used to cool the incoming compressed helium before it is recirculated through the compressor. When the gas in the cryostat has been cooled to about twenty degrees absolute, it is liquefied by an adiabatic expansion through a needle valve.

The cryostat cabinet contains an experimental chamber in which temperatures down to two degrees absolute can be maintained. Liquid helium for experimental work in external apparatus can be transferred to a separate *Dewar* through the draw-off tube. (*A Dewar vessel* is a double-walled vacuum flask named after its inventor, Sir James Dewar, a Scottish chemist, who




Arthur D. Little & Co.

**Flow diagram of the Cryostat.**

**Liquid helium being drawn off from the cabinet of the Cryostat in the Cornell cryogenics lab.**

was the first to obtain liquid and solid hydrogen. Liquid helium is usually kept in *double Dewars,* in which it is surrounded by a vacuum space, a jacket of liquid nitrogen, and another vacuum space.) The cryostat can be used to liquefy other gases by circulating them through coils surrounding the liquid helium chamber.

One of the major problems of liquefying helium which this machine overcomes is keeping the helium gas free of impurities which would freeze out and clog the apparatus. The compressor is specially built to keep the oil from vaporizing into the gas. The gasometer in which the helium is kept for recirculation is also free of any substance which might contaminate the helium.

Most of the experiments being carried on in the lab are merely extensions of experiments which can also be carried on at higher temperatures. However, one experiment, being carried out by Dr. George Yntema, can be carried out only at low temperatures. Dr. Yntema is studying the flow of heat in liquid helium.

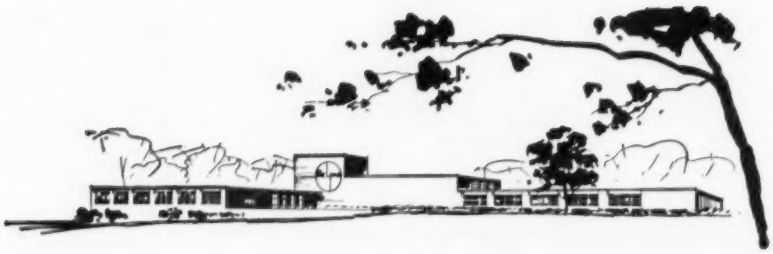
The boiling point of liquid helium is about 4.2 degrees Kelvin. Down to about 2.2 degrees, helium acts as a normal liquid. At 2.2 degrees—the so-called *lambda point* —the liquid undergoes a phase transformation from helium I to helium II. Helium II acts as if it were a mixture of two liquids, called the normal component and the super component. The normal component acts much like helium I, but the super component has many remarkable properties. First of all, it has no measurable viscosity. One result of this property is that helium II in a glass vessel would flow up the sides of the vessel and over the top! The two components of helium II seem to be able to flow independently. It is thought that there is no friction between the two.

Dr. Yntema's apparatus is designed to measure this friction, if any. In his apparatus, liquid helium in a Dewar is cooled to below the lambda point by rapid evaporation through an exhaust pump. Inside the Dewar, there is a tube filled with helium II sealed off at the top. The bottom of the tube is in a bath of helium II, and the top is kept at a temperature very slightly above that of the bath by a heater. The super component flows up the tube towards the heater and the normal component flows downwards. If there is no friction between the components of the helium II, the temperature gradient in the tube should be proportional to the pressure of the liquid. If, however, the fluids do interact, the temperature gradient will increase more rapidly than the pressure.

An interesting sidelight is that, of the two isotopes of helium that occur naturally, only that of atomic weight four exhibits these properties. The other isotope (At. wt. 3) has been cooled to within a few tenths of a degree of absolute zero with no evidence of a lambda point. A theory on why liquid helium acts at it does was developed by Professor Feynman of the California Institute of Technology.

Another experiment being carried out in the low-temperature lab deals with internal friction in copper crystals and the effects on internal friction of dislocations, that is, slight imperfections in the structure of the crystal. In this apparatus, a copper crystal is suspended across two wires and set vibrating

*(Continued on page 67)*



# A message to the engineer with tomorrow on his mind

*—From Melpar, One of the Nation's Leading Electronic Research & Development Organization*

Melpar's sure, swift growth during the past 11 years — we have doubled in size every 18 months — is due, in large measure, to the outstanding performance of our engineering staff.

Our organization is continually called upon to perform tasks which have never been done before. Thanks to the creative talent which forms the backbone of our organization, we have grown both in stature and size. Members of our staff have enjoyed similarly rewarding growth.

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As Melpar grows so do members of our staff. Individual recognition is a *fundamental* policy at Melpar. Should you join our staff you will advance *solely* on the basis of your performance on the job.

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At Melpar complete facilities for creative research and design are available. Our headquarters laboratory near Washington, D. C. encompasses 265,000 air-conditioned square feet, is ultra modern in design and equipped with an eye to *both* present and future needs.

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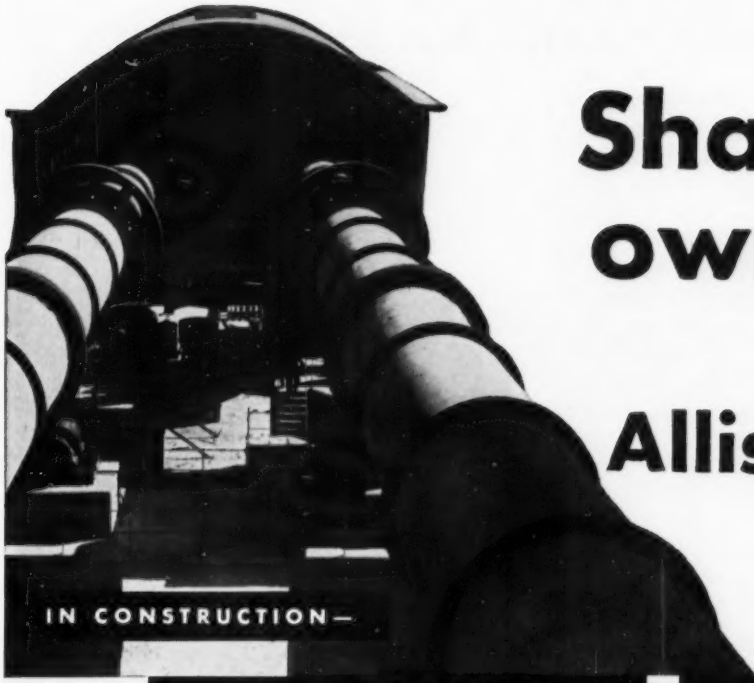

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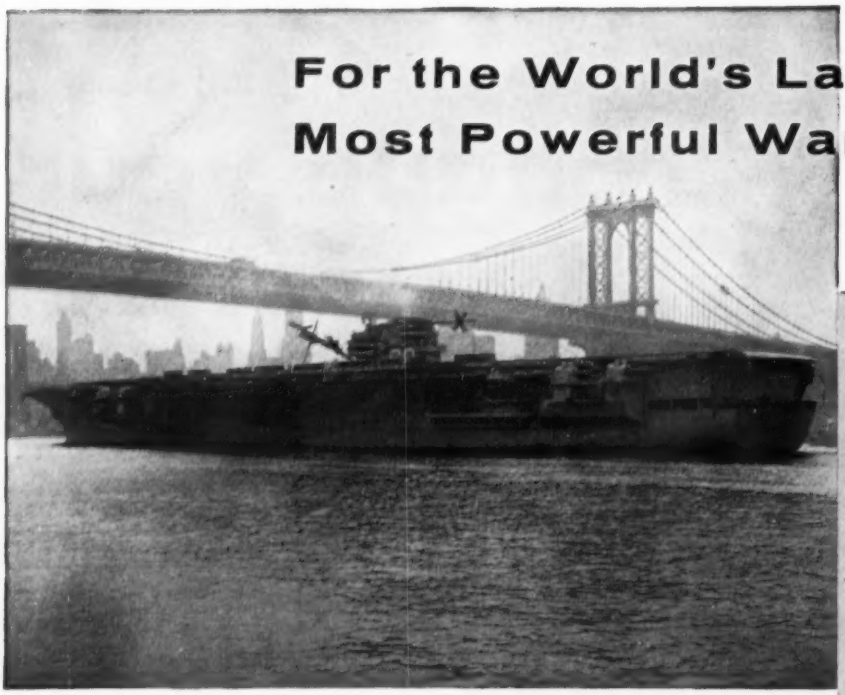

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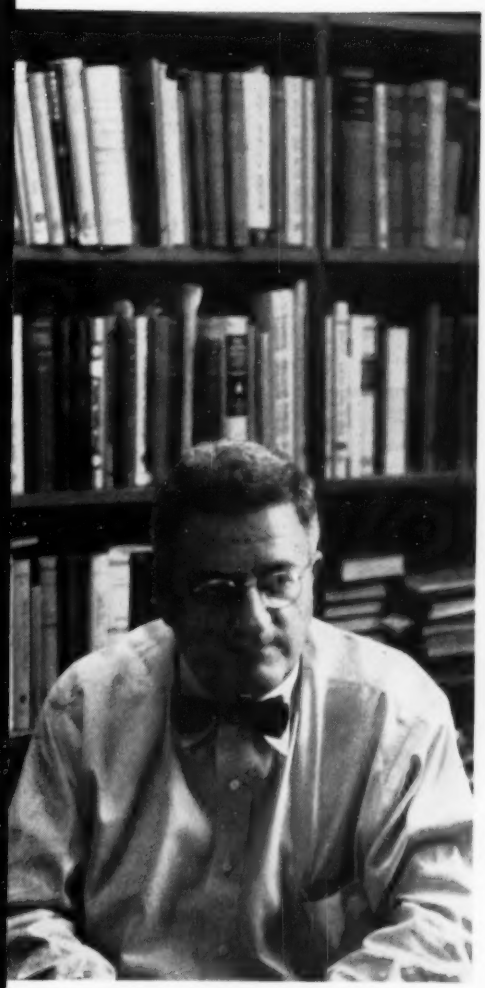

## Faculty Profile . . .

# PROFESSOR HENRI S. SACK

by

Benson J. Simon, EE '60

In the northern corridor of the first floor of Rockefeller Hall may be found the office of a very happy man; he is Professor Henri S. Sack of the Department of Engineering Physics who says that anyone who, like himself, has the dual opportunity to teach Cornellians and to continue his own research work is in a most enviable position.

Professor Sack was born in Davos, Switzerland, studied in Zurich, was an "assistant" at Zurich and then Leipzig, and an instructor-researcher at Brussels before coming to the United States in June, 1940. A few months after his arrival in this country, he was appointed a Research Associate at Cornell. His work was concentrated on internal friction and the elastic properties of solids, and much of his work since then has been closely related to this field. One of his early projects here was in the application of ultrasonics to the detection of flaws in the wooden structure of airplanes. The work was successful in the laboratory but the techniques were never adapted to practical usage.

During World War II, Professor Sack taught physics courses for engineers and did considerable work on computers. He was made an Associate Professor in 1946 and was one of the original group of faculty members appointed to the Department of Engineering Physics when it was founded that year. In 1949, he was named a full professor.

About this time, preliminary work had been completed by graduate students on methods of determining moisture content of soil, and Professor Sack and Professor T. R. Cuykendall went to work to perfect an instrument that would make such determinations with a minimum of effort on the part of the investigators. Its primary use was to be for studies of drainage problems on airfield runways and the research was subsidized by the Civil Aeronautics Administration. Formerly, when any such measurements were made, the rather primitive and time consuming method of digging large holes and withdrawing samples was used. A light, small instrument was needed that could, if desired, be buried permanently in runways at several points to keep a constant check on the moisture content of the earth below. The solution proved to be a device which was known as the "Atomic Finger." It consisted of a short rod about three-quarters of an inch in diameter which was connected to the recording portion of the instrument by a cable. To obtain a direct reading at any spot, the rod need only be lowered into a narrow hole drilled by an auger. On the rod was a neutron source and a counter.

When neutrons strike matter, they are deflected in all directions, some bouncing back to the source. The more moisture in the soil, the sooner the neutrons are deflected after leaving the rod and more neutrons are likely to come back to the source. Therefore, a curve can be plotted relating the number of neutrons returned to the known moisture content of the soil and this can be used for making future determinations.

The instrument had been produced by 1950 and that year, the first report on its performance was issued. However, the Federal Government reduced appropriations to the Civil Aeronautics Administration and they had to discontinue subsidies for future work. Research was continued, though, by the Army Corps of Engineers at the Waterways Experiment Station at Vicksburg, Mississippi and other places. At the Vicksburg installation, soil studies for regular runways and emergency landing strips are carried on along with the basic task of building huge scale models of harbors and rivers for use in guiding construction of port facilities and flood control projects.

Six years ago, Professor Sack took a sabbatical leave from Cornell to work at the Sandia Corporation's laboratories at Albuquerque, New Mexico. The company is administered by Western Electric and is supervised by the Atomic Energy Commission. Here, he worked

on analog computers for systems analysis. A patent was just granted to him on one of the computers used for target analysis for missile delivery. Another device on which he worked is now being produced for the armed forces. It determines the best aiming point and the expected damage for a given target and missile system. Most information on it is classified but we can say that it helps a commander to choose the best missile for use in a given situation.

For the last six or eight years, part of Professor Sack's research at Cornell has been supported by the Office of Naval Research, and later by the Office of Scientific Research of the Air Force. He and Professor Cuykendall have just issued for the ONR a report on the "Dynamic Elastic Properties of Solids". A recent report by one of his students, L. Kamentsky, is one of the most comprehensive studies of single metal crystals and their behavior over a temperature range of 4°K to 1000°K. Research is also being done in another field of solid state physics on photo conductivity and luminescence of ionic crystals.

Along with all his other research work and instructing at the University, Professor Sack has, for the past two years, been named to the endowed professorship of the Cornell Aeronautical Laboratory. This post, which is rotated every few years among different professors, entails his flying to Buffalo every Thursday afternoon during the school year to deliver a series of lectures. Last year's lectures were on transistors from the point of view of theoretical solid state physics; that is, why they behave as they do. This year's lectures deal with the application of solid state physics to engineering materials. Fatigue, yield points, fracture strength, and motion of dislocation are among the topics discussed. Personnel at C.A.L. are given time off to voluntarily attend the lectures.

Some of the courses that Professor Sack teaches at Cornell include "Electronic Properties of Solids and Liquids," and "Mechanics of Continua." These deal with lattice structures and defects, elastic properties, dielectric and magnetic properties, equations of motion in continuous media, and other areas of solid state physics in which he has also done research. He works with graduate engineering physicists on projects of applied science in any field. Some being worked on now besides those already mentioned, include electromicroscopy and corrosion, particularly of magnesium.

Although Professor Sack spends a great deal of his time in the world of crystals, atoms, and subatomic particles, he derives much of his pleasure from the life and atmosphere of teaching the students at Cornell. The informal relationship between professors and students here is in sharp contrast to the ways of his native Europe, and, both he and his students fully realize the invaluable, intangible satisfactions and benefits of this way of learning.

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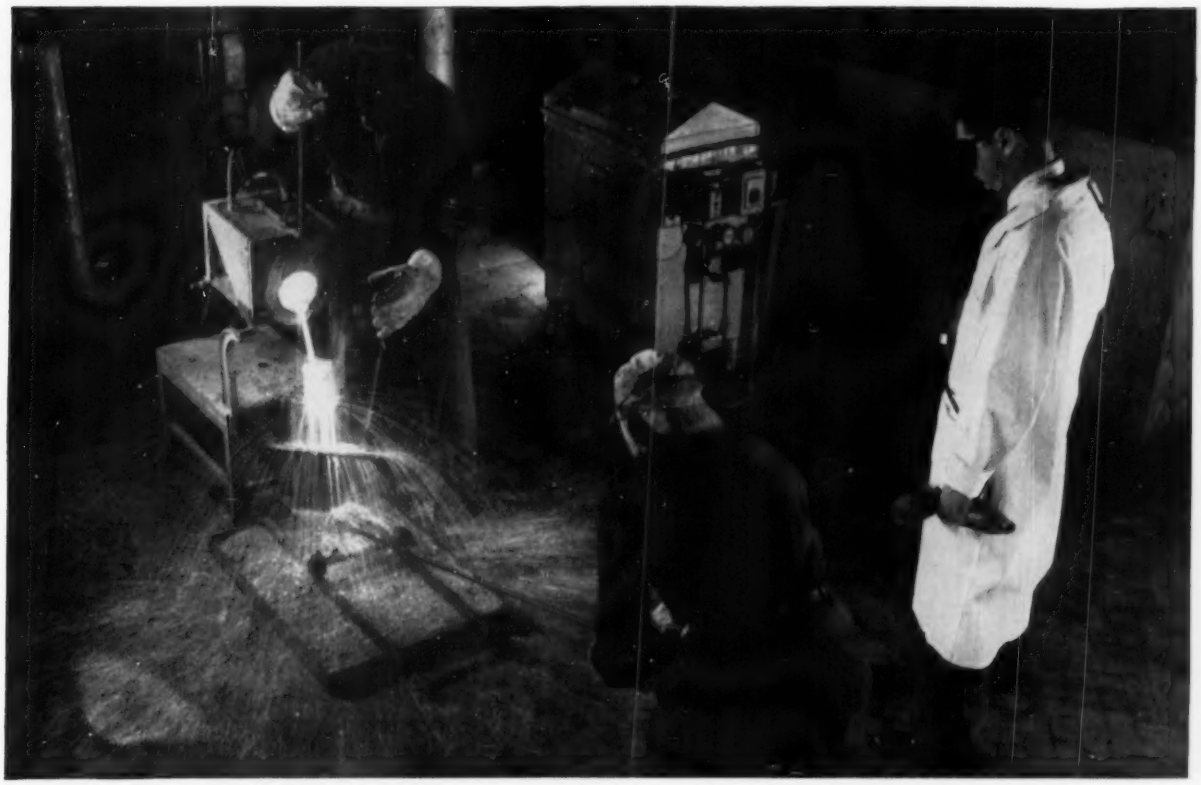

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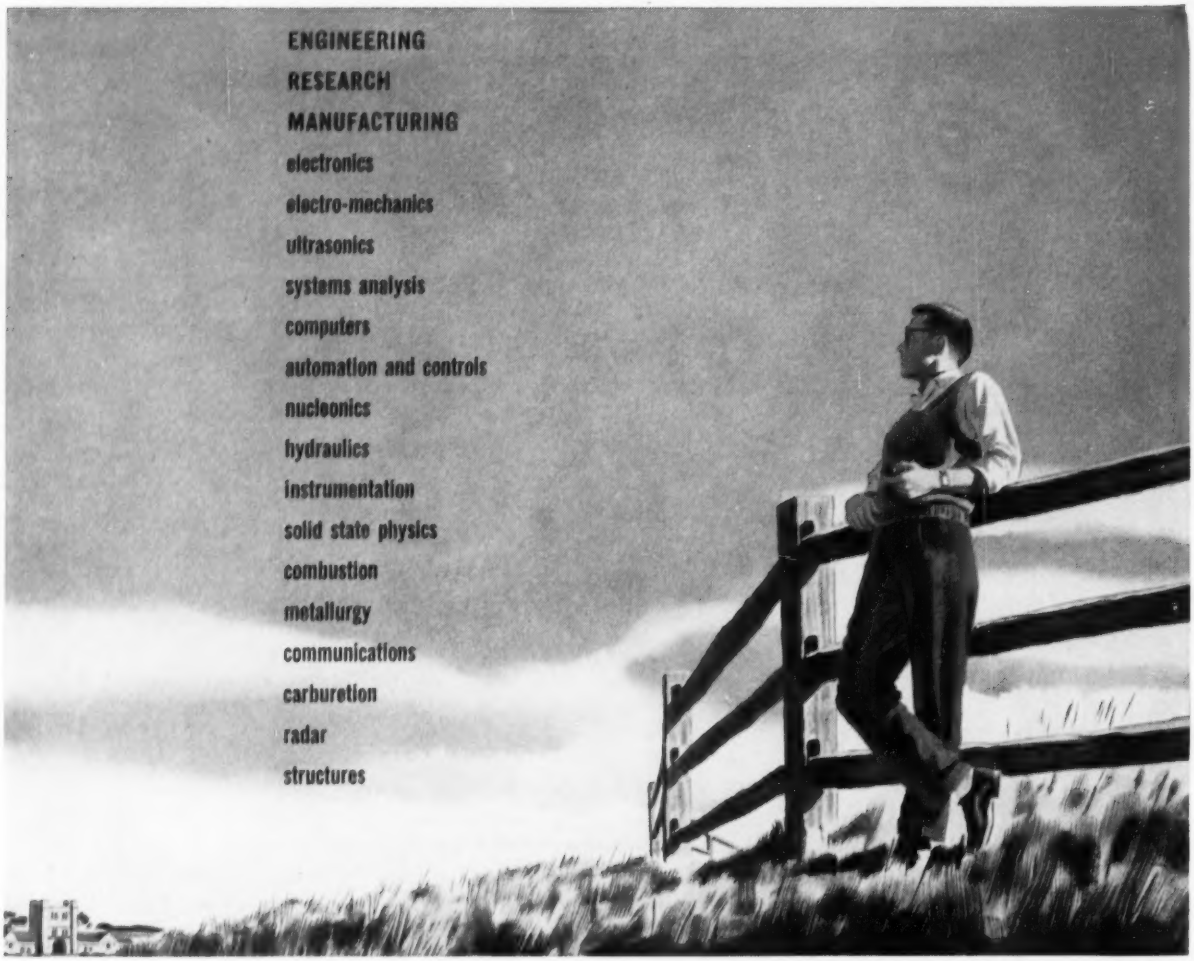


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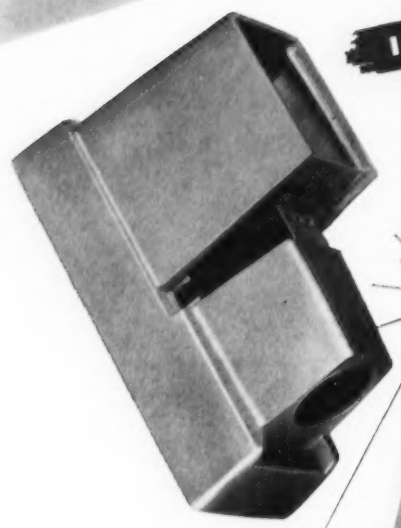

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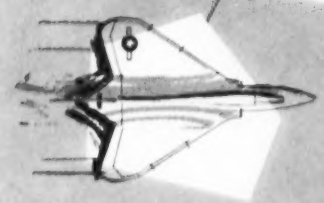

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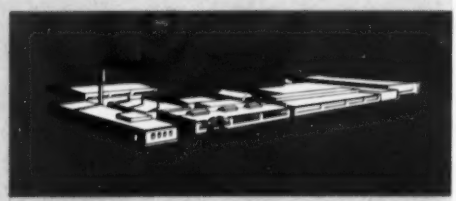


# RESEARCH INSTITUTE for ADVANCED STUDY

by

John A. Bewick, EP '60

Industrial leaders have realized in recent years that too little fundamental research is being undertaken in proportion to the rapid progress made by industry in applying existing principles to practical problems. Many industries find themselves limited in their advancement by insufficient knowledge of the fundamental principles involved. Thus they are becoming aware of their responsibility to stimulate increased basic research.

Industry has responded to the need for basic research in many ways. Bell Laboratories have conducted much research in the telephone industry; Dupont is famous for its work in the chemical industry; and General Motors has recently completed a new research center for the automobile industry. Yet more extensive basic research in every field of science is essential if we are to maintain our nation's leadership in the rapidly advancing age of technology. Perhaps the most imaginative and most promising plan for increasing our country's store of basic knowledge is Research Institute for Advanced Study (RIAS) proposed by the Glenn L. Martin Company and patterned somewhat after Princeton's Institute for Advanced Study.

In the last several years, the Martin Company has found that developments in new concepts of flying are being hampered by a lack of fundamental knowledge of aerodynamics, propulsion, metallurgy, etc., and "has further concluded that American Industry must assume a far greater responsibility for encouraging *basic research* if any very marked change of pace is to be realized," according to W. W. Bender, vice-president in charge of RIAS.

The Company's approach to conducting this fundamental research is unique. Martin officials believe that it is possible to stimulate basic research with the management techniques they now employ in their advance design projects. They also believe that it will be possible to establish conditions under which the researchers will be able to realize their maximum productivity. RIAS will seek to accomplish this by eliminating administrative burdens (especially clerical work) and increasing funds, equipment, and personnel, thus giving the researchers more time for creative study. The company believes it is possible to stimulate and to guide creativity just as successfully in the field of research as in advanced design engineering.

The Martin Company is initiating RIAS activities by employing a staff which will number about one hundred fifty people when complete, many on a post-doctoral level, who will be provided with facilities to experimentally test their theories. These researchers will be sought primarily from qualified people who are presently engaged in applied research rather than from college teachers who are in demand for training the researchers of the future. The projects planned thus far are mainly in the physical sciences though not necessarily limited to these fields. So far RIAS has undertaken studies in mathematics, metallurgy, solid state mechanics, Einstein's Theory of Relativity, and others. The staff will have the responsibility for originating and carrying out its own projects. If the Company's hopes are fully realized, RIAS will be comparable to Princeton's Institute for Advanced Study with additional facilities provided for extensive experimentation.

The company believes that fundamental research should be profitable in itself in order to encourage more people to pursue scientific careers. Mr. Bender stated that because fundamental research is in the interest of the public, it should be established on such a basis that it would be attractive to scientists. This would, of course, stimulate greatly our present research effort. Both government and private industry would undoubtedly be interested in buying knowledge gained from this research. The Martin Company, for example, has already bought several fundamental papers in aerodynamics and physics from European scientists and is hopeful of buying additional ones. Thus, basic research should be profitable for the research men engaged in it.

In the past, scientists often complained about their low pay. From the standpoint of industry, scientists often have narrow responsibilities. RIAS is establishing a scale of wages for scientists which will be on a similar basis to that employed in paying engineers. The research institute is eliminating clerical details from their scientists' responsibility. However, RIAS believes that scientists should have greater responsibility for making the administrative and general policy decisions which affect their work. Mr. Bender stated that "The staff would be encouraged to create its own program and would in no way be constrained to product problem solving or product development, which so often chokes off long-range research endeavors." Most scientists in a college community do not have the management training which would aid them in speeding up their research. Too often, scientists overlook their responsibility to society. RIAS is seeking to create an awareness of the scientists' responsibility and to increase their effectiveness.

The aircraft industry is inherently concerned with long-range projects; and, in this case, the Company is thinking in terms of long-range benefits to the country as well as its own business. Although the new research center offers no direct return to the parent company, the board of directors and stockholders foresee many intangible benefits from such an institute, with possible direct help to the airplane industry. Some indirect benefits have already become a reality. Higher caliber engineers are applying for positions at Martin's and the company is better known throughout the nation. Already a metallurgist on the staff of RIAS has made a discovery which is being applied by the Martin Company. Furthermore, the Company will acquire a background in conducting research which may result in unforeseeable benefits in the future. For example, their study of intercontinental air travel ten years ago resulted in the company receiving a major part of the contract for this country's first satellite project. This is an example of the rewards the Martin Company anticipates from its new research center.

RIAS presents a new outlook on conducting basic research which promises to greatly stimulate our existing research effort. Industry has a definite responsibility for sponsoring research which it must meet if we are to keep pace with our technical advancements. However, industry sponsored research poses many questions: Can industry create conditions which will foster successful creative research? How will scientists react to such an institute? Who should pay for research? Can industry supply the same type of stimulation which scientists now encounter at universities? Several scientists and an engineer were interviewed on campus to get their reactions to the ideas proposed by RIAS in an attempt to answer these questions. Their reactions went like the following:

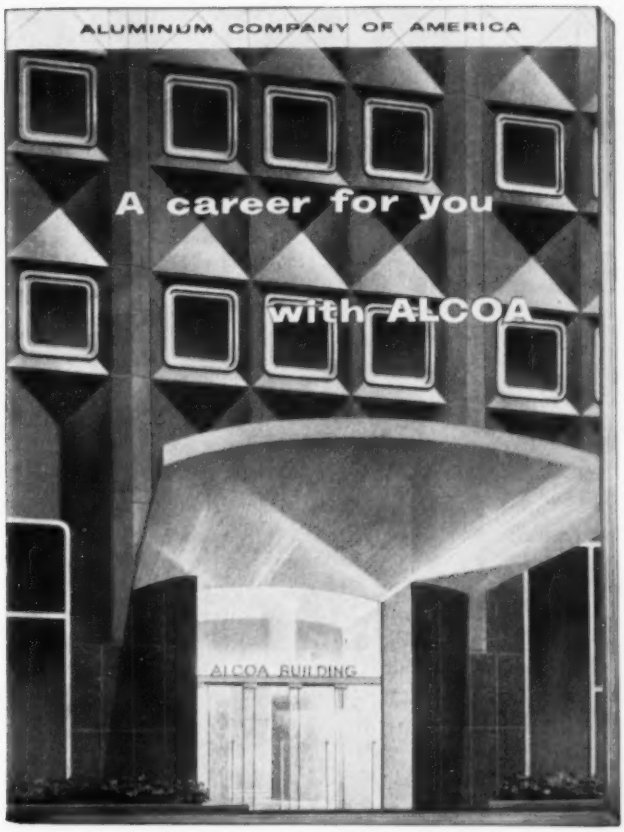
Professor H. S. Sack, of the Physics Dept., gave me the impression that it is impossible to combine business and research. He questioned the sincerity of industry in conducting purely fundamental research since, he pointed out, industry is primarily interested in money-making. Even though scientists may be relieved of some administrative duties, he believes that the researchers who are paid higher salaries for greater responsibilities will not actually have more time for creative thought. Professor Sack points out that at Princeton's Institute for Advanced Study, the scientists have a lack of definite responsibility for producing a specified number of papers and ideas. Professor Sack believes that this freedom which is allowed the researchers is to a large degree responsible for its success. If research is placed on a profit-making basis, Dr. Sack believes that industry would discriminate against projects which offer little or no financial reward but which might be very worth-while scientifically. Scientists who are truly interested in their work would not need to be stimulated by the techniques employed in industry. Important factors for successful creative thought are stimulation by inquisitive people (usually students) and conditions under which people will be stimulated. For success RIAS will have to attract high-caliber scientists and should have a famous director (like Dr. Bethe) with administration taken care of by industry.

Professor D. L. Gunder, former Director of the Department of Engineering Mechanics and Materials, had a favorable reaction to the plans expressed by RIAS. Professor Gunder believes that, in a large majority of cases, man is basically lazy and produces only when necessary. Consequently, management techniques would be very beneficial in stimulating research. However, success of the project will depend on the quality of leadership provided. The professor suggested RIAS sponsor personnel exchange with universities, a professor going to RIAS for a period of 4 to 5 years and a RIAS scientist going to the university for the same length of time. This period would enable each individual to become adjusted to his new surroundings and to have time to accomplish something significant. Such research would greatly augment our present supply of basic knowledge.

Professor P. L. Hartman, of the Physics Dept., expressed the thought that RIAS could be successful if it is not connected with industries' dollar-making interests. He stated that the primary factor necessary for basic research is stimulation such as that given by students. RIAS would apparently be taking the scientists away from his source of stimulation. He suggested that the Martin Company might do as well by donating money to universities instead of building their own research institute. Furthermore, he points out that good scientists will be attracted to RIAS only if some top men in the country are persuaded to do research there. With these conditions RIAS should be a tremendous success.

RIAS has introduced a promising approach to basic research which seems destined to be successful in a few years. RIAS answers a need for greater industrial support of basic research and should stimulate other industries to sponsor similar projects. It is obvious that if research were more profitable more people would be encouraged toward scientific careers and our existing research effort would thus be greatly enlarged. Likewise, with extensive facilities and few admin-

*(Continued on page 59)*

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# ETHICS AND ENGINEERING

by

Leonard Pisnoy, CE '57

Excerpts from the Second-Prize Winning Article in the annual Charles Lee Crandall Contest, 1956, for Civil Engineers

The future of the engineering graduate is promising. His prospects, as outlined in many job offers, are high salaries and steady advancement. He is courted by excellent living conditions and a professional climate in which to develop. Business is opening its heart and its "pocketbook" to the graduate.

Let's take a closer look at the bright sunrise awaiting the engineer and see if the few grey clouds portray a deeper meaning to our future, the engineering profession.

A profession is based upon a heritage of knowledge accumulated through centuries of human effort. Interwoven throughout the profession is a code of ethics which forms the cement binding the entire structure. This code defines the ground rules; how each practitioner should act toward his client, toward his fellow members, and toward the public. It is "a code of behavior specifically agreed upon by professional men to enhance the standing of their practice through respect for truthful findings, informal judgment and knowledgeful procedure, and suggestions toward the realization of goals."

Basic to the profession is a direct relationship between its ethics and its degree of professionalism. If we have no ethics we have no profession.

Engineering ethics are a mode of life, of expanding characteristics where each engineer is expected to act in every situation in a manner that will add to the confidence and respect which the public holds for his profession.

The senior members of our engineering societies realized how important ethics are. Thus, eight societies banded together to form the Engineering Council for Professional Development. This group laid the groundwork for engineering ethics in 1947 when it adopted a code known as, "Canons of Ethics for Engineers." This has since been accepted by more than eight engineering societies.

We have briefly seen how important ethics are and we may wonder what can be done to improve engineering ethics. To do this we must first analyze the problems present in our profession and then formulate a plan of action.

Some of these problems are:

1—Unionization of engineers.

2—Bribes and kickbacks.

3—Competitive bidding for professional services.

4—Unprofessional advertising.

5—Non-professional treatment by firms employing engineers.

Engineering unions have grown because the rate of increase of engineers' salaries has not kept pace with todays starting salaries and factory workers' wages. Is a salary of $500 per month, after five years experience, comparable with today's starting salary of $425? Many engineers feel that unions can help them obtain greater personal compensation. Professional unions have been formed at General Electric and Bell Telephone. These unions have acted on a high professional plane during negotiations. Thus, the usual union connotations of labor strife are not applicable to these professional unions.

The conflict of engineering unions and ethics seems to be apparent when we consider that the engineer is serving society for its improvement rather than being concerned solely with monetary gain. However, we must remember that economic survival is a prerequisite for any degree of professional activity. If engineers cannot earn wages commensurate with their ability and social standing, then we have no right to call engineering a profession.

The effect of engineering unions should be combatted with a strong national engineering society which will have the power to take effective action not only with respect to salaries but also to improve the engineering profession. This society, if it is to effectively subordinate unions, must demonstrate to firms why engineers' salaries should be adequate. If it cannot do this, then our only recourse is engineering unions.

Kickbacks and bribes, according to reports, have been received by some engineers. When an engineer assumes the responsibility of awarding contracts, his job is to grant the contract to the firm which will do the best work for the least fee. When he is placed in a position of approving work, which is to be done according to specifications, his professional ethics should countermand any financial offer to overlook certain details. Strong professional ethics will prevent kickbacks and bribes. Moreover, if the engineer's salary is sufficient, he will be less tempted to accept illegal offers.

Competitive bidding for profes-

# — A FIFTH YEAR ENGINEER SURVEYS A CHALLENGE OF HIS PROFESSION

sional services violates The Code of Ethics of The American Society of Civil Engineers. Yet, the State Highway Department of South Carolina advertised that bids would be received for making plans and specifications, and checking shop drawings for a movable highway bridge (clearly a professional service). Thirteen engineering firms submitted bids, disregarding the code. Mr. Joseph H. Ehlers, in the December 1953 issue of "Civil Engineering," commented on this by saying, "It has long been the general conclusion that competitive bidding for professional services is not compatible with professional status. It is the fundamental basis for any past and present considerations of the question of whether we as engineers wish to continue engineering as a profession like law or medicine or develop it into a business as construction contracting or manufacturing."

Competitive bidding harms the public. When a firm competes on a price basis, its interest is in performing minimum professional services that will yield the lowest bid. Money is basically spent for professional engineering to save on the total cost of the project. Usually the lowest cost is brought about by spending a maximum, not a minimum, on engineering analysis and design.

Competitive bidding for professional services can be attributed to the large growth of engineering firms. These firms have to constantly meet a huge payroll. Thus, the firm must keep its men busy to remain big. Recently, many engineering firms have been plagued with a highly competitive market. As a result, they have been forced to obtain work through competitive bidding and laudatory advertising. It appears that the fight for the firm's survival is much greater than the sound practice of professional ethics.

The atmosphere created by this situation moulds the individual in this unethical environment. He has to comply with the firm's manner of doing business or possibly lose his job. The engineer's economic status determines whether he can comply with his professional ethics. Is the character of an engineer such that he must blindly follow unethical practices of a firm? Or is he one who has matured in a professional atmosphere and thus has the courage to comply with his convictions?

These infringements upon the A.S.C.E. Code of Ethics have caused the society to discuss the question of whether competitive bidding and laudatory advertising can be considered ethical. This possible reversal would be consistent with present practice, but would it increase the stature of the engineering profession? It definitely would not. We have previously seen why competitive bidding is wrong. Laudatory advertising degrades the dignity of the profession. We have direct and open violations of professional codes of ethics, and a society, which desires to eliminate the codes, causing the violations. This is not the way to help our profession. If our laws are being violated we need an effective agency to condemn and punish the guilty parties. We cannot have a profession if we are going to eliminate its code of ethics. Must we reverse all the progress within the field of engineering ethics that has been assimilated during the past twenty years?

An estimated 65 to 75% of American engineers are employed in industry. Many of these men are faced with the perplexing problem of non-professional treatment. This seems to stem from two basic causes. Management in many firms has not developed sound personnel principles. Also many engineers are assigned tasks not commensurate with their professional abilities, commonly called "hack work."

If the engineer is not satisfied with his job, his work will reflect his attitude. Thus, his performance will not measure any test of ethical relationship toward his profession.

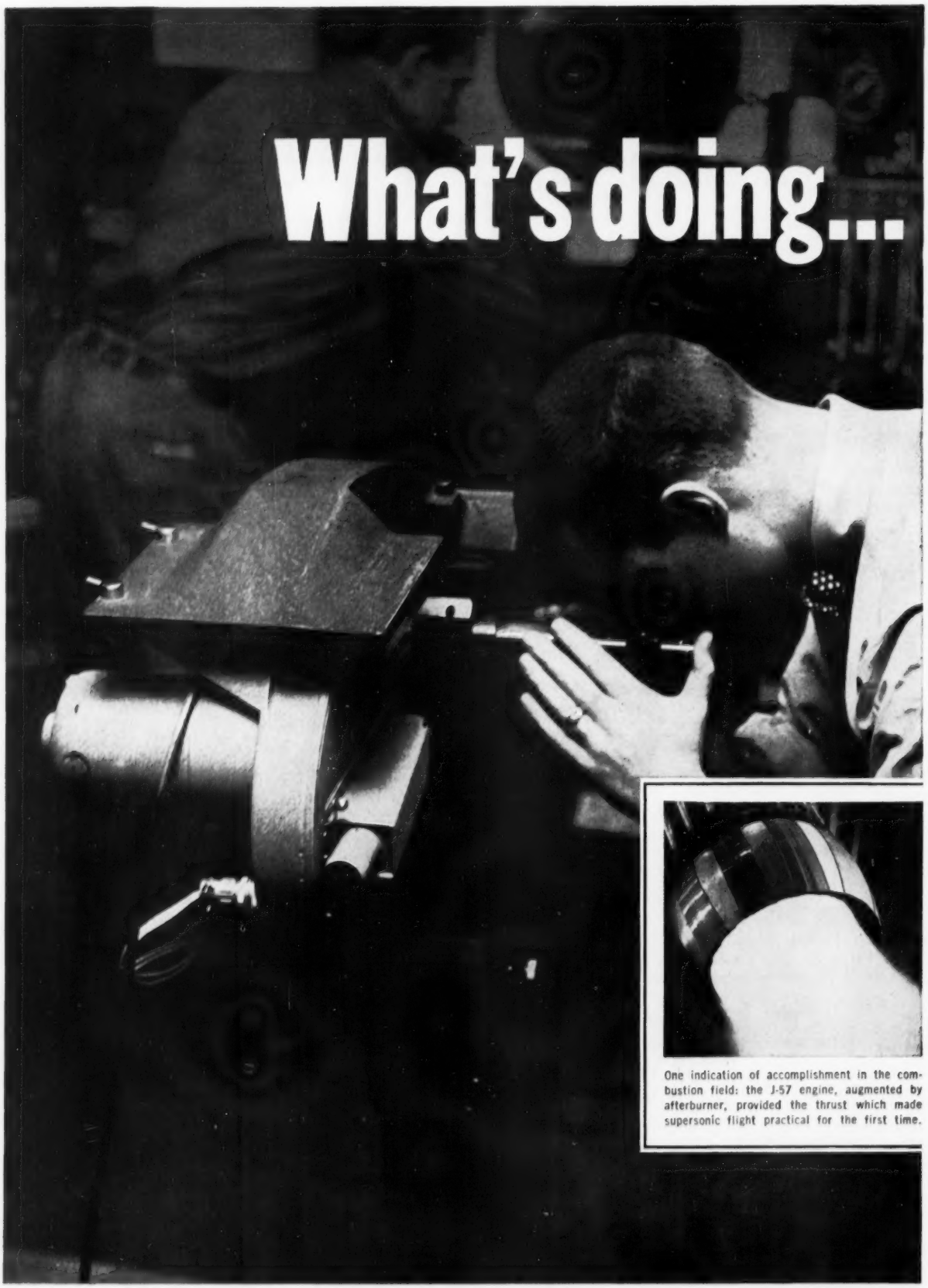
We have thus far examined only a few of the problems present in engineering ethics. But, the underlying causes can give us answers to the question of how engineering ethics can be improved.

Today, at college, where the engineer receives his formal training, he combines a knowledge of science, mathematics, humanities and engineering courses to form his foundation. Most people will readily agree that our educators are producing technically competent engineers. But, we may condemn the educators for not preparing their students to understand professional ethics.

The late Daniel W. Mead (C.E. '84) with over fifty years of professional experience, and an authority on engineering ethics, wrote his book, "Standards of Professional Relations and Conduct" (adopted by A.S.C.E., Manuals of Engineering Practice No. 21) because, "In his college work the writer does not remember that he ever received any material information on professional relations or professional conduct. He was obliged to gather such information in the expensive school of experience and 'hard knocks.' He has always felt that he might have done much better work and made many less errors if there had been available, during that period, the experience and conclusions of those who had already trod the difficult road to successful professional practice."

To emphasize the importance of teaching the essentials of our profession, The American Society for Engineering Education's Committee on The Promotion of Ethical Standards concluded, "If the young

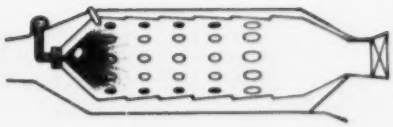
*(Continued on page 61)*




One indication of accomplishment in the combustion field: the J-57 engine, augmented by afterburner, provided the thrust which made supersonic flight practical for the first time.

This special periscope gives Pratt & Whitney Aircraft engineer a close-up view of combustion process actually taking place within the afterburner of an advanced jet engine on test. What the engineer observes is simultaneously recorded by a high-speed motion picture camera.

# at Pratt & Whitney Aircraft in the field of Combustion*



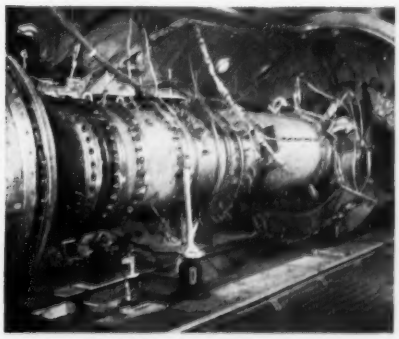
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

Perhaps at no time in history has that fascination been greater than it is today with respect to the use of combustion principles in the modern aircraft engine.

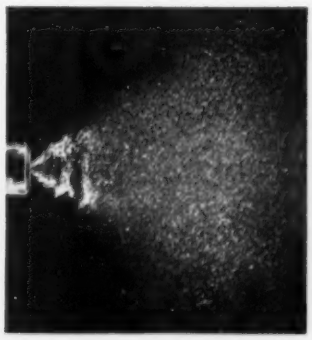
At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid mixing of burned and unburned gases involves a most complex series of interrelated events — events ocurring simultaneously in time and space.

Although the combustion engineer draws on many fields of science (including thermodynamics, aerodynamics, fluid mechanics, heat transfer, applied mechanics, metallurgy and chemistry), the design of combustion systems has not yet been reduced to really scientific principles. Therefore, the highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the vision, imagination and pioneering efforts of those at Pratt & Whitney Aircraft engaged in combustion work.

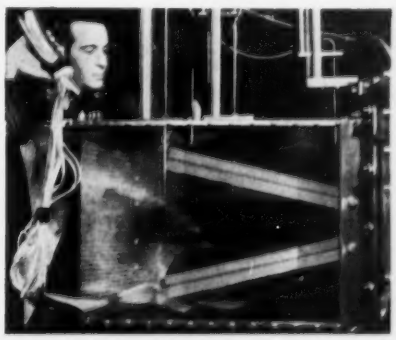
While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design and aerodynamics — spells out a gratifying future for many of today's engineering students.



Mounting an afterburner in a special high-altitude test chamber in P&WA's Willgoos Turbine Laboratory permits study of a variety of combustion problems which may be encountered during later development stages.



Microflash photo illustrates one continuing problem: design and development of fuel injection systems which properly atomize and distribute under all flight conditions.



Pratt & Whitney Aircraft engineer manipulates probe in exit of two-dimensional research diffuser. Diffuser design for advanced power plants is one of many air flow problems that exist in combustion work.

*Watch for campus availability of P & W A color strip film on combustion.*

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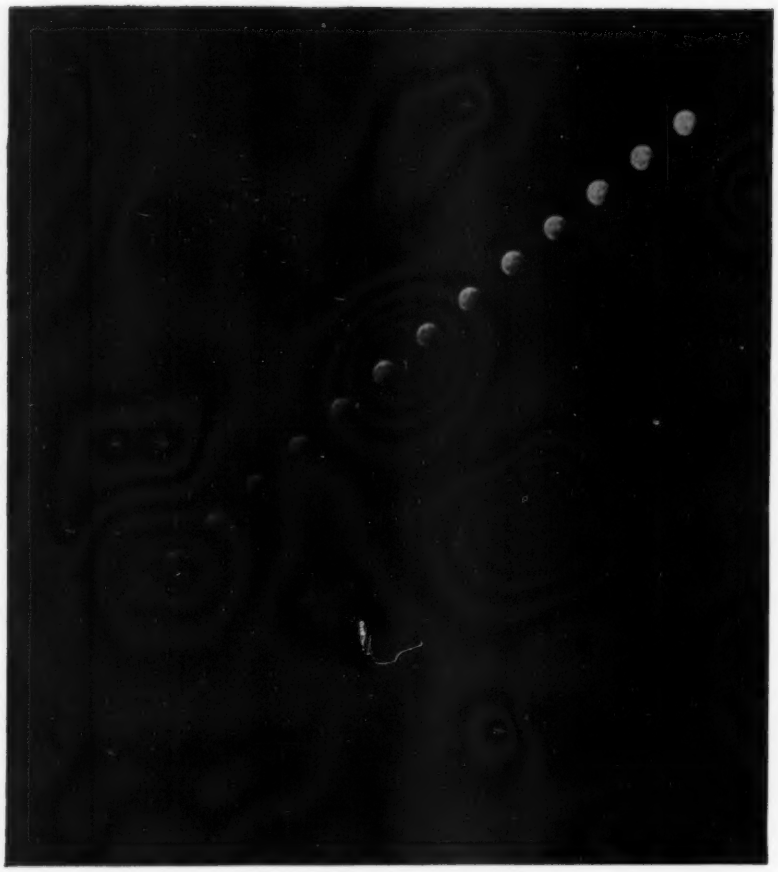

# many moons

Less than 5,000 working hours from now, Martin will launch the world's first earth satellite. As with the famed Martin Viking Rocket program, this is to be No. 1 of a continuing series of astronautical research vehicles—man-made moons which will chart the way toward the conquest of the final frontier, space itself.

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# College News

## PHOTOMICROGRAPH EXHIBIT

Outstanding photographs of metallic structures were on exhibit in Olin Hall during the week of November fifth to November fourteenth. The photographs were the prize winners in this year's contest sponsored by the American Society for Metals in order to stimulate interest in photographic techniques in metallurgy.

Most of the photomicrographs were made in the following manner. First, the specimens were mounted in a block of plastic and cut through the area to be examined. The resulting surfaces were machined to a very high degree of smoothness. The specimens were then etched with acid to bring out the crystalline structure, and were photographed under a microscope.

The grand prize went to Donald Mannes of the Virginia Polytechnic Institute for his photomicrograph of eutectic silicon in slowly cooled aluminum-silicon alloy. One of the exhibits, showing the motion of dislocations during the bending of a lithium fluoride crystal, appeared on the cover of the September, 1956, *Journal of Applied Physics*. This photograph won honorable mention in its class. Others included a study of a 300-year-old nail and a color photograph showing the temperature distribution in the inaccessible parts of a turbojet engine.

## MASTER'S DEGREE PROGRAM

Professional Master's degrees in chemical, civil, electrical, industrial, mechanical, and metallurgical engineering are being offered by the Cornell Graduate School in a program that began this fall. The degrees will be supervised by the Engineering Division of the Graduate School, which was formally organized on January 26 of this year.

The professional programs are aimed especially at two groups—graduate engineers employed in industry and outstanding students just finishing engineering school.

The new program offers engineers employed in industry near Ithaca a chance to gain recognition in the form of a degree for advanced courses they may take at Cornell, for, although the new degrees require fifteen credit hours for work on the Ithaca campus, they do not require full-time residence at the University as does the Master of Science degree.

The second group is composed of the outstanding members of the graduating classes at Cornell and elsewhere who wish further curricular type training.

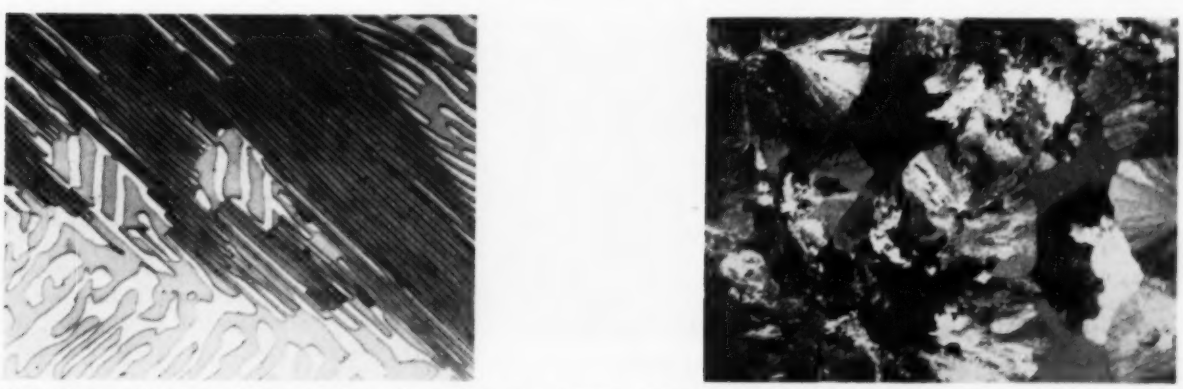
Both of these groups are faced with common problems in an era of rapidly advancing technology. They must be familiar with the advances in a particular field of engineering as well as discoveries in the basic sciences related to their field.

Many prospective students already have experience in research of basic or developmental character; others may be in positions or seeking employment where they will not be called upon to do research, but where advanced training in technical subjects is indispensable. The need is not to educate these men in the methods of research, but rather to offer them the opportunity to study subject matter concerned with the latest technical advancements and to acquire new techniques and skills.

The new degrees, therefore, are not research degrees, as in the case of the M.S. and Ph.D., but are completely curricular in nature.

The Department of Engineering Physics is the only division of the Engineering College which does not at present offer a Professional Master's degree. The Department is, however, represented on the Graduate Committee of the College of Engineering; and it is possible that a degree of Master of Engineering Physics will be offered in the future.

The degrees require forty-five hours of advanced work, at least fifteen of which must be taken after the candidate has received a baccalaureate degree. Cornell engineering students may complete the master's degree in a minimum of one term beyond the fifth year of engineering study. The program is expected to take at least three terms for a graduate of a four year course.



**Photomicrographs taken of Copper-Indium alloys illustrate a common eutectoid phase transformation in metal alloy systems. Left: Structure composed of two low temperature phases which have formed from the high temperature phase (solid grey areas). Right: Structure of two low temperature phases at high magnification.**

## AUTOMATION CONFERENCE

Cornell University was one of eight schools to participate in the eleventh International Instrument Automation Conference of the Instrument Society of America. This exhibit, held in the new New York Coliseum, took place on September 17-21, 1956.

The Instrument Automation Conference has been a yearly event, sponsored by the McGraw-Hill Publishing Co. The company sponsors the exhibit "to acquaint America's technical leadership with the quality and originality of the non-commercial student and faculty research conducted at universities and technical institutes." It is the sponsor's hope that through the exhibits, industry will develop a greater interest in the research being carried on by these institutions to the extent that the companies will offer grants, scholarships, and endowments.

The schools participating in the exhibit were M.I.T., Princeton, Tufts, Yale, Johns Hopkins, Penn. State, Rensselaer, and Cornell.

Our booth featured a testing machine for the experimental investigation of dynamically loaded journal bearings. The machine was developed here at Cornell by R. M. Phelan for his M.M.E. thesis.

Basically, the machine consists of a connecting rod loaded by a flat spring, one end of which is driven by a variable eccentric and connecting rod, while the other end is attached to an adjustable pivot. The eccentric is driven by a variable-speed dc motor to provide a sinusoidally varying load component. The pivot adjustment introduces a steady load component.

The most useful expression for performance of a hydrodynamic bearing is in terms of the minimum thickness of the oil film, which varies rapidly with time. Two photo-electric displacement pickups are used, each mounted on one side of the load and at a 45-degree angle to it. Their signals are fed into the *X* and *Y* inputs of a cathode ray oscilloscope, where they are added vectorially, giving a dot which represents the point halfway between the journal and the bearing, the middle of the oil film. Four SR-4 strain gauges and a dynamic strain bridge convert the load into an electrical signal which is displayed on another oscilloscope as a load-time curve.

The machine has proved very valuable to students doing research work. Since its development in 1950, it has been used by undergraduate students involved in their fifth year project work and by graduate students involved in master's degree work.

**Automation and Instrumentation Exhibit.**

## REACTOR MOCKUP

Cornell's Engineering Physics Department has just obtained a new tool for instruction and research in atomic energy. This addition, called a sub-critical assembly, is actually a small-sized reactor. The instrument was constructed to provide students at Cornell with practical experience in the field of nuclear reactors.

Essentially, the assembly consists of two concentric cylinders—one two feet, the other four feet in diameter—resting about one and a half feet above ground on a "U"-shaped bed of stone blocks. Ordinary water fills the tanks and acts as a moderator.

The mock reactor requires natural uranium as its fuel, plus a highly radioactive source. The uranium is encased in one inch diameter hollow aluminum rods. The source is a polonium and beryllium mixture, delivering about 25 curies of radiation. These materials are placed in the assembly as follows: first, the uranium bearing rods are lowered one by one into the smaller cylinder. Then, they are arranged in a pre-determined matrix form. When the rods have been properly placed, the Po-Be source is set in the oven shaped opening of the stone base.

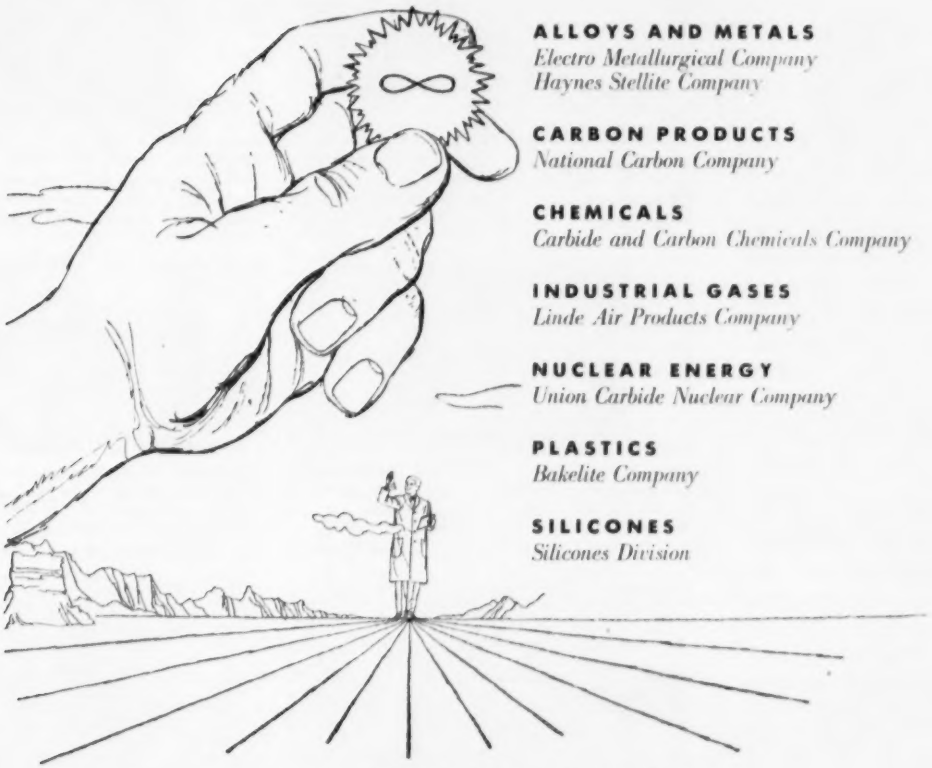
The instrument rests in one corner of a 450 sq. ft. "L" shaped room in the basement of Rockefeller Hall. The room is piped so that either tank of the assembly can be filled independently with water. The wiring is sufficient to accommodate a great deal of electronic equipment.

The assembly has many interesting features that broaden its area of use. Across the top of the inner tank there lies a grating that permits variable lattice arrangements. Cadmium rods can be plunged into the moderator water to demonstrate control rod action. Two aluminum tubes pass far enough into the assembly to provide moderately strong "neutron beams." Finally, it is interesting to note that water can be removed from the outer tank, while the inner remains filled. In this way, the differences of reflecting and non-reflecting type reactors can be demonstrated.

*(Continued on page 54)*

# THE HORIZONS ARE UNLIMITED

## for college graduates at UNION CARBIDE



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# Color TV is here!

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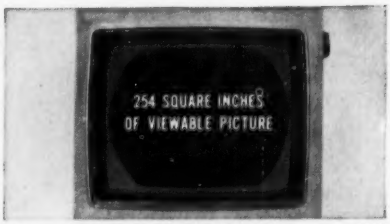
**Now, more than ever,** new engineering skills and techniques are needed in the television industry – to keep abreast of the tremendous strides being made in Color TV. RCA – world leader in electronics – invites young engineers to investigate these challenging opportunities. Only with RCA will you find a scientific climate particularly suited to the needs of young engineers. Your knowledge and imagination will be given full rein. Rewards are many.

Your talents are needed in research – in TV receiver design – in network operations – even "backstage" at TV studios. The experience and knowledge you gain can take you anywhere!

**WHERE TO, MR. ENGINEER?**

RCA offers careers in TV and allied fields – in research, development, design and manufacturing–for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. Join the RCA family. For full information write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, New Jersey.

**Like 2 sets in 1—get Color and black-and-white shows, too!** It's RCA Victor Compatible Color TV. See the great Color shows in "Living Color"—regular shows in crisp, clear black-and-white. With Big Color, you see *everything.*




**Big-as-life 21-inch picture tube — overall diameter.** Actually 254 square inches of viewable picture area. And every inch a masterpiece of "Living Color." Here are the most natural tones you've ever seen—on a big-as-life screen!

**Color every night — right now! Something for everyone!** You'll have "two on the aisle" for the best shows ever—drama, comedies, Spectaculars, children's shows, local telecasts. For now 216 TV stations are equipped to telecast Color.

**Big Color TV is so easy to tune, even a child can do it!** Turn two color knobs and there's your Big Color picture! It's easy, quick, accurate. It's a new thrill when the picture pops onto the screen in glowing "Living Color."

**Practical and trouble-free! Service at new low cost!** Big Color is *dependable* Color. And RCA Victor Factory Service is available in most areas (but only to RCA Victor owners). $39.95 covers installation and service for ninety days.

**Color TV is a common-sense investment—costs only a few cents a day.** It's sure to become the standard in home entertainment for years to come—yet you can enjoy Color every night *right now!* And you can buy on easy budget terms.

**Now starts at $495 — no more than once paid for black-and-white.** This is the lowest price for Big Color TV in RCA Victor history! There are 10 stunning Big Color sets to choose from—table, consolette, lowboys, and consoles, too.

**Make sure the Color TV you buy carries this symbol of quality.** Because RCA pioneered and developed Compatible Color television, RCA Victor Big Color TV—like RCA Victor black-and-white—is First Choice in TV.

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# TECHNIBRIEFS

## LABORATORY REACTOR

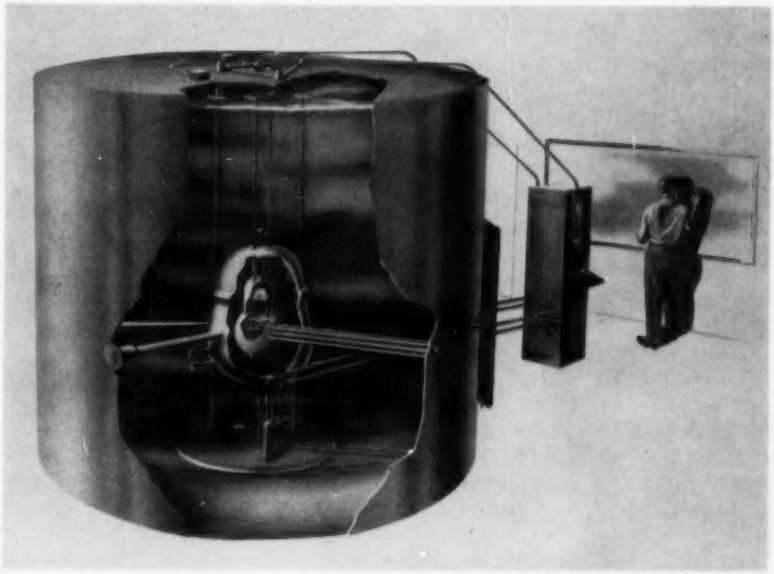
Design of a miniaturized low-cost atomic energy reactor small enough to fit into any school, industrial, or medical laboratory was announced by Atomics International, a division of North American Aviation, Inc.

The compact "Laboratory Reactor" is contained in a tank only eight feet high and eight feet in diameter, and can be installed in any existing laboratory building without the addition of any special facilities.

Priced at $55,000 the Laboratory Reactor can be constructed, installed and ready-to-run at any location in less than six months.

Designed specifically for small laboratories, the reactor will permit a wide range of research and training in the nuclear field. Operating at a power level of only five watts, the reactor will provide sufficient radiation for important studies in the engineering, biological and medical fields.

The "core" of the reactor, where atomic fission takes place, is a one-foot stainless steel sphere containing about four gallons of enriched uranyl sulfate in a water solution. This core, surrounded by a six-inch thick lead shield, is housed in an eight foot tank filled with ordinary water. A number of exposure facilities and beam tubes are provided to permit several experiments to be carried on while the reactor is operating.



**New low-power nuclear research reactor designed for use by educational institutions and research laboratories is only eight feet high and eight feet in diameter. The reactor is operated from a simplified control console (right).**

## EDUCATIONAL TV

The nation's first state-wide and state-supported educational television network is now programming to 90 per cent of the State of Alabama.

The network was inaugurated by Governor James E. Folsom as a third station (WAIQ, Channel 2) went on the air from Andalusia, marking completion of the system.

Two of the stations in the network—WBIQ (Channel 10) at Birmingham, and WTIQ (Channel 7) at Munford—have been on the air since early 1955. The addition of WAIQ at Andalusia completes the network.

The stations are joined by microwave relay stations to telecast programs simultaneously from originating studios at the University of Alabama, Tuscaloosa, the Alabama Polytechnic Institute, Auburn, and from the Greater Birmingham Area Educational Television Association, Inc.

All studios and transmitter stations have the latest in modern telecasting equipment found in many of the larger commercial stations. WAIQ and WTIQ have 100 and 316 kilowatts of effective radiated power respectively, and WBIQ has 30 kilowatts.

The network is currently programming 45 hours per week, going on the air at noon each weekday and broadcasting until nine in the evening. About 30 hours a week is devoted to live programs.

Since the start of educational telecasting early last year, viewers throughout the state were able to see the first telecast of a complete opera on educational television in the nation when "La Boheme" was presented from the studios at the University of Alabama.

Forty-six Alabamians enrolled for the state's first college credit course on educational television, studied biology in the comfort of their living rooms, and received two hours credit at the University.

Thousands of Alabama school children have studied reading, writing, mathematics, music, and government via television in the classroom.

Students have been able to prepare for college entrance examinations by reviewing English, Spanish and mathematics on the educational channels.

The addition of the third station and final link of the network will now bring similar programs to 90 per cent of the state.

Programs for the network are supplied by the three programming agencies—the University of Alabama, Alabama Polytechnic Institute, and the Greater Birmingham Area Educational Television Association, Inc.

Each agency is responsible for one-third of the programming time. Programming policy is handled by a program board set up by the Alabama Educational TV Commission. Within each programming agency there is a local executive committee to formulate policy at that level.

## SPECTROHELIOMETER

A "sun sleuth" that has kept its automatic eye glued on the sun continuously for two years at Mi-

ami, Fla., may help unravel the mystery of what some of the sun's rays do to auto finishes.

Called a Spectroheliometer, the device recently tracked the sun from dawn to dusk for 8,104 hours, recording the amount and intensity of certain parts of the sun's light that are known to have a weathering effect on paints, lacquers and enamels.

It automatically transfers the "evidence" on graph paper for researchers to study. Data from hundreds of feet of graph lines are still incomplete, but researchers have uncovered some incidental intelligence.

For example, the Spectroheliometer indicates the Miami Chamber of Commerce may claim one point in favor of its sunshine. The instrument reports it five times brighter or more intense than Detroit's sunshine.

Also, a so-called solar "twinkle" appears in Detroit's industrial atmosphere apparently caused by invisible puffs of smoke floating through the air.

Developed in 1952, the "sun sleuth" underwent a year's trial at Detroit before it was shipped to the Florida Test Field near Miami.

So far as researchers know, the instrument has produced the first continuous spectral record of the sun's daily behavior.

It was used at Miami to find out first how much sunlight falls on the Florida Test Field in a year. This gave researchers a measurement yardstick for indoor laboratory tests with a so-called "Little Florida" device in which paint samples are exposed to artificial sunlight from a 1,200-watt high pressure mercury vapor lamp.

By knowing how much sunlight drenched Miami annually, researchers could expose paint to similar amounts of intense laboratory "sunlight." In a period of weeks they hope they may duplicate many months of outdoor exposure at Miami, and any speedup of testing tempo is a research bonus.

Meantime, while the Spectroheliometer was in service, researchers put new auto finish sample panels on exposure racks each month at Miami. This was done to find out how much paint weathering varied from month to month.

The amount of weathering on each new panel each month is being correlated with the Spectroheliometer's reports of varying intensities and amounts of the sun's radiation, rain or shine.

Later, a research project was set up to determine how much sunlight varies in amount and intensity from sunrise to sunset through the four seasons of the year. This indicated that at Miami's latitude a paint sample panel in a fixed position took its worst "beating" from the sun either during spring or fall.

Meanwhile, studies of all this accumulated information are under way—part of an overall effort to make automotive finishes even more durable than they are today.

The instrument follows the sun's path in the same manner that astronomical telescopes follow paths of the stars. It picks up the sunlight and passes it through a spectrograph. This breaks the light into a color band stretching from the "red" to the "blue" lights of the sun's spectrum.

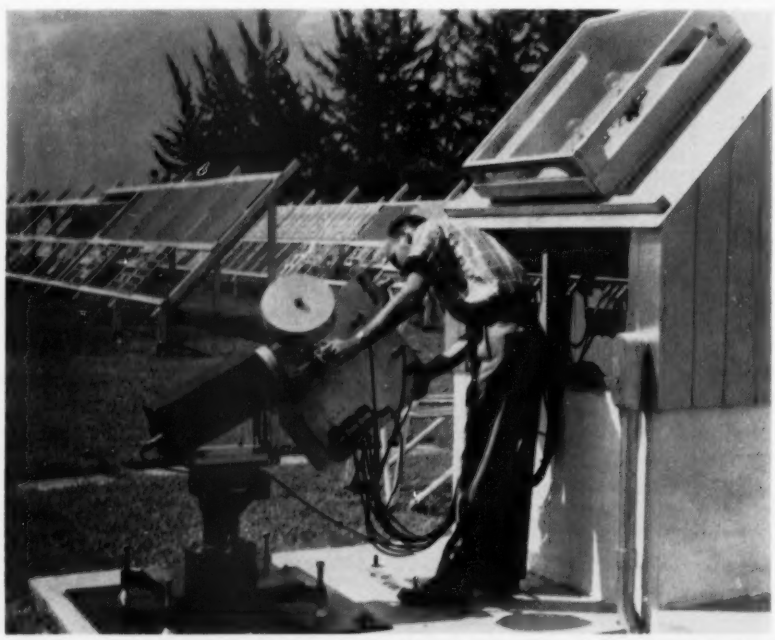
Thermopiles convert five of the various light bands into electrical signals that are amplified approximately 100,000 times so that both amount and energy intensity of each band can be recorded on graph paper.

## TRANSISTORIZED POWER CARRIERS

Another significant milestone in the progress of electric utility equipment was achieved when the first completely transistorized power line carrier assemblies were placed in full operational service. Installation of the equipment at each end of the 132-kv Marlowe-Reid line climaxed a series of field tests that Westinghouse engineers have been conducting on the Potomac Edison lines since 1953.

Use of transistors in this type of equipment has brought about several marked advantages resulting in lower installation, operation, and maintenance costs. Installation time has been cut in half due to the compactness and simplicity of the new design. Instead of erecting a steel cabinet some 72-inches high by 26-inches wide and 16-inches deep and then laying interconnecting wiring to the relay switchboard, all the new equipment is contained in a Flexitest® case 22-inches high by 6-inches wide and 6-inches deep. This case is then directly mounted on the switchboard, and only one adjustment need be made before the unit can be placed in operation.

Moreover, the compactness of design has decreased the substation



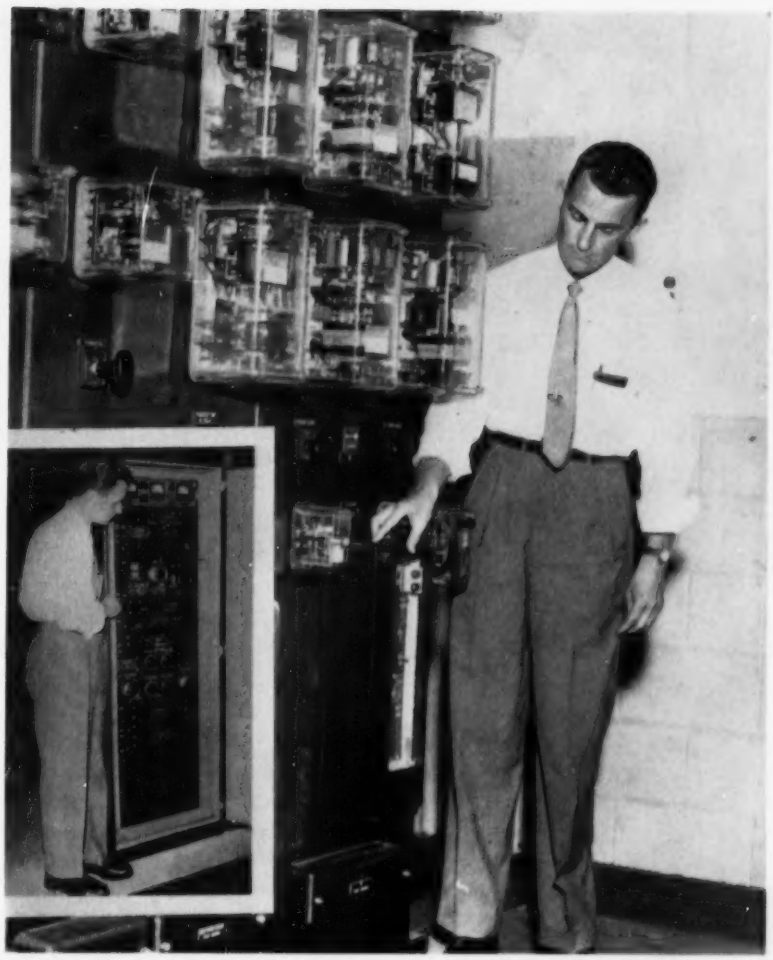
**For more than two years at Miami, Florida, this unique instrument, the Spectroheliometer or Sunshine Spectrum Recorder, has made a continuous record of intensity of sunlight in various parts of its spectrum. The record is correlated with the weathering of automotive finishes (on exposure racks in background) in an effort to find out which parts of the sun's spectrum cause finishes to deteriorate.**

space taken by the equipment. Instead of the three square feet of floor space and 18 cubic feet of substation space required by conventional equipment, the new units require practically no floor space and only one cubic foot of substation space. This results in lower substation investment costs where space is at a premium.

The simplicity of design has lowered operating and maintenance costs. Since no vacuum tubes are employed, the transistors require no periodic checks. As compared with three months to a year life for the average vacuum tube, transistors can be expected to last indefinitely.

The power consumption of the transistorized equipment is very low: 18 watts as contrasted with the 250 watts required by conventional assemblies. This results mainly from the fact that transistors require no filament current, where most of the power is normally consumed.

Power output is approximately one watt, but sufficient sensitivity has been provided to operate through a channel attenuation of 40 decibels. Previous equipment on this installation was designed for a 33-db channel.



**The first all transistorized power line carrier assembly is installed at the Marlowe Dispatching Center of the Potomac Edison system, and mounted directly on the relay panel associated with the line being protected. Note the relative size of the older type carrier equipment inserted at the lower left.**

## WAMOSCOPE

A radically new type of cathode-ray tube for radar, television, and other electronic display applications has been developed by Sylvania Electric Products Inc. in cooperation with the Naval Research Laboratory. The new electronic device is being demonstrated publicly for the first time at the Western Electronic Show and Convention.

The "Wamoscope," as the new tube is called, represents a significant step in the simplification, increased reliability and versatility of many types of electronic equipment, including radar and television systems. It combines most of the essential functions of a microwave receiving set in a single-tube envelope, eliminating many of the tubes and components required by conventional receivers. This simplification results in increased reliability of the equipment.

Dr. Robert M. Page, associate director of research for electronics at the Naval Research Laboratory, explained that in a radar receiver utilizing the "Wamoscope," microwave signals go directly from the antenna into the tube, where, in a single envelope, the signals are amplified, detected, and displayed on the tube's fluorescent screen. "Compared with a conventional radar receiver, this means that the local oscillator, mixer, intermediate frequency amplifier, detector, video amplifier, and their associated circuitry are eliminated," he added.

An important feature cited by the Navy scientist was the wide selection of channels possible in the "Wamoscope," which operates over a microwave frequency band of 2,000 to 4,000 megacycles. Additional "Wamoscope" types are now under development.

The present "Wamoscope" is just under two feet in length, with a screen diameter of five inches, but there is no practical limitation to the size of the tube face or the type of screen; these would be determined by the applications of the device.

"Wamoscope's" initial uses will undoubtedly be in radar and in military closed-circuit television; however, future industrial and commercial applications of the device in non-military fields, as has been the case with other technological developments related to armed service requirements are foreseen.

## PLASTIC-STEEL SHEETS

A new product, combining the structural strength of steel with the rich decorative effects of vinyl plastic in an almost limitless variety of colors and textures, has graduated from the research laboratory and is now in experimental production at U. S. Steel's Irvin Works in Dravosburg, near Pittsburg, Pennsylvania.

*(Continued on page 70)*

# This could be YOU—near

ACTUALLY, it's "Andy" Ashburn, Managing Editor of *American Machinist*. Andy holds a B.S.E. from the University of Michigan, and progressed with his magazine from Assistant Editor to Associate Special Projects Editor to Managing Editor since joining McGraw-Hill Publishing Company. Like most of the 485 full-time editors on the McGraw-Hill "team", Andy is an engineer *first*—a writer second. And unlike most engineering graduates his age, Andy is already near the top of his chosen field.

Ask him what he thinks about a writing career for engineers and he'll tell you this: "All through college, I was a staff member of *The Michigan Technic*, and editor as a senior. And I've never stopped being grateful for the decision I made to be an engineer-writer. I've learned more about what's going on . . . kept in touch with key developments in engineering throughout industry . . . thanks to that decision."

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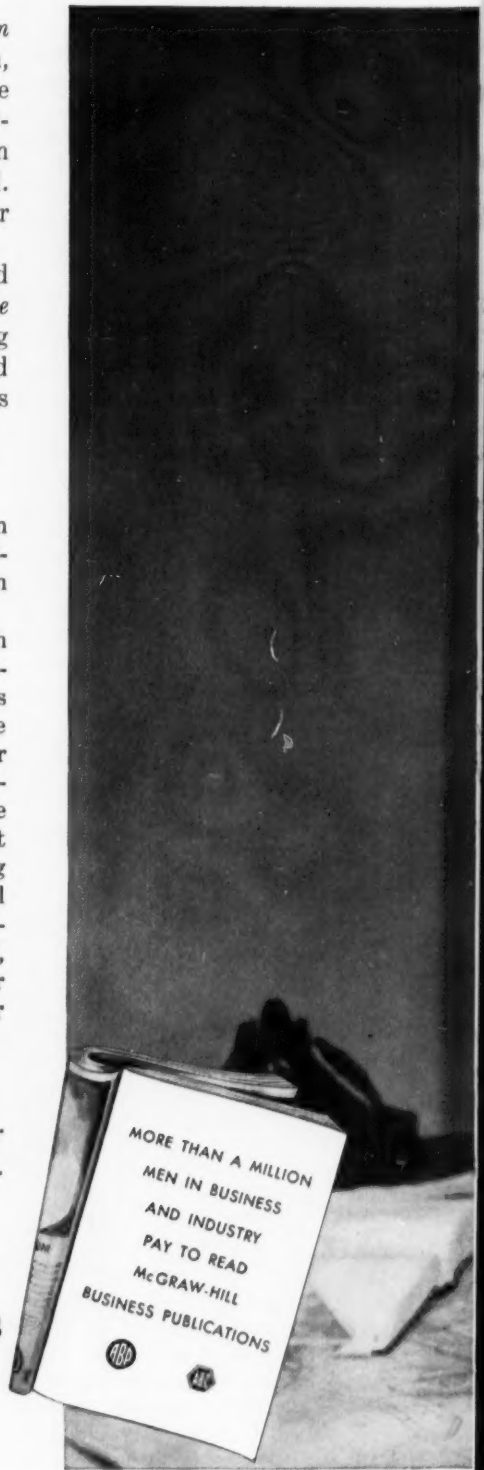


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## Book Review . . .

# Contracts, Specifications, & Engineering Relations

by Daniel W. Mead, Rewritten by the Staff of Mead and Hunt, Inc., H. W. Mead, Pres., and Joseph Reid Akerman, Revisions Editor and Principal Author—McGraw Hill, 1956

Reviewed by R. Y. Thatcher

Professor Emeritus, Civil Engineering

This book has had a long and interesting history. It was originally written by Daniel W. Mead in 1916 for use of his classes in hydraulic and sanitary engineering at the University of Wisconsin, and for private circulation only. Its favorable reception resulted in the publishing of the first edition later in the same year. In 1920 a second edition was published, with a reprint in 1924.

Daniel W. Mead received the B.C.E. degree at Cornell in 1884, and the degree of LL.D. from the University of Wisconsin in 1932. After an outstanding career as a practicing consulting and construction engineer, engineering educator, and author, he died in 1948. His son Harold W. Mead has followed very closely in his father's footsteps. He graduated from the University of Wisconsin with a C. E. degree in 1920 and has since been engaged in a wide range of engineering and consulting practice with special emphasis on hydraulic, hydro-electric, and water conservation projects. Since 1939, he has been president of the consulting firm of Mead & Hunt, Inc. Principal author of the 1956 third edition of the Mead book is Dr. Joseph Reid Akerman, Associate Professor of Mechanical Engineering, University of Wisconsin.

In preparing the third edition, the authors have followed the general pattern of earlier editions as to chapter headings and content, but much of it has been rewritten, reorganized, and its applications and illustrations brought up to date. The 400 pages of text in the second edition have been streamlined to about 300 in this new edition. The reference list of literature at the end of each chapter in the second edition has been omitted, and in the place of this there has been inserted a list of thought-provoking questions and case situations which will constitute a valuable teaching aid for college classes. The avowed purpose of this book, from its early beginning, has been to set forth the important relations with which the engineer or architect should become familiar when starting his professional career. Elaborating upon this idea somewhat, the reviewer concludes that there are two general objectives, or two ways in which he believes the book will have an almost unique value to all engineers, both young and old.

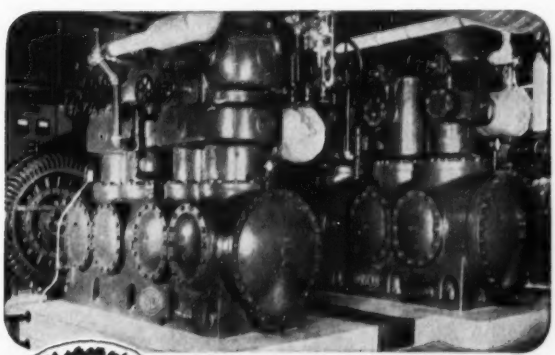
In the first place, Chapters 1 - 6 contain an orientation of the younger engineer into the profession, as well as a design for living and formula for success. It could almost be said that Daniel Mead's life was a long crusade for a higher standard of ethics and moral principles among members of the engineering profession. This was evident in both his life and his writings. As one of the means to the above end, he was instrumental in promoting many essay contests with prizes offered for articles written on various aspects of professional ethics. In fact as a memorial to Daniel Mead, one such contest is being conducted among the members of student chapters of A.S.C.E. at the time of this review. Hence it is not surprising that the first several chapters of our book cover such matters as The Engineer and His Education, Success in the Engineering Profession, The Engineer at Work, and Personal and Ethical Relations. The next two chapters relate to the very pertinent subjects of The Use of English, and Letters and Reports.

The second general objective would appear to be a comprehensive appraisal and discussion of the whole field of construction and contracting procedure. This of course is of extreme importance in all branches of engineering, as well as in the interrelated fields of manufacturing, public works projects, and business in general. And because legal relations are always involved in one way or another with the activities of the engineer in the construction field, Chapters 7, 8 and 9 are devoted to Origin, Nature and Development of Law; Legal Relations, Rights, and Responsibilities of Technical Men; and the Elements of Contracts. The remain-

ing chapters describe all phases of a construction project from its inception to completion and operation. This includes such related matters as the decision between owner versus contractor construction, the several different types of construction contracts, competitive bidding and the method of award, and recommended practice in the writing of the various necessary contract documents with particular emphasis, naturally, upon the technical specifications. Appendix A comprises in 115 pages a complete set of contract papers and specifications for a typical modern construction project involving a dam, power house, and necessary equipment for a public utility company—a very fine example of specification writing. The reviewer considers this portion of the book to have been very well written. It is an excellent summary of the many aspects of construction planning. A few minor omissions might be noted. No mention appears to have been made of the growing use of prequalifications questionnaires in order to restrict bidding to qualified parties; of the frequent requirement that contractors furnish a payment bond as well as a performance bond; and of the recent trend toward enlisting the help and advice of competent contractors in the preparation of both design and specifications, to ensure greater economy, practicability, and fairness to all parties concerned.

As pointed out by the authors, this book is not intended as a text in Engineering Law, although it might well be used as an introduction to such a law course. Many engineering schools now offer a curriculum and degree, or at least an option, in Construction Engineering. The Mead book would serve admirably as a text for a first course in such a field, to be followed by a second course in Engineering Law which would include not only contract law but more detailed treatment of such legal subjects as agency, sales, real property, negotiable instruments, business organizations, suretyship and insurance.

It is quite evident that the book reflects the firm belief of both Daniel and Harold Mead that an engineer should not only be well trained in the technical aspects of his profession, but should also be a good businessman, a good citizen, and a man of the highest personal character. Although this book is written primarily for the use of engineering students and may well be used as a bible for younger engineers who are at the beginning of their professional career, it would also be a valuable addition to the library of practicing engineers of any age.

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## *Closeups . . .*

# ENGINEER FACULTY ADVISORS

These closeups are on the retiring and new faculty advisors to the ENGINEER. Also retiring as faculty advisor is Professor William H. Erickson, now Director of the School of Electrical Engineering. The ENGINEER published a profile on Professor Erickson in the December, 1950, issue.

### PROFESSOR J. E. HEDRICK

All Cornell chemical engineering students now take a course in chemical engineering economics given by the man who started it several years ago, Professor J. E. Hedrick of the School of Chemical Engineering. Professor Hedrick has realized that the engineering graduate of today needs a knowledge of economics when he goes into industry. In his course, Professor Hedrick supplies chemical engineering students with this much-needed background.

Born in Meredosia, Illinois, Professor Hedrick received his A.B. from Illinois College in 1931 where he majored in chemistry and mathematics. A few years later, he received his M.S. and Ph.D. in chemical engineering from the State University of Iowa.

Professor Hedrick's first job after graduation was with the Iowa Public Health Department where he worked on the analysis of the freshwater supplies in Iowa. He then became an instructor in chemical engineering at Kansas State College. Here, in addition to his teaching duties, he was able to do research at the college engineering-experiment station.

Professor Hedrick has always been interested in petroleum refining, so much so that he wrote his thesis on the high-pressure properties of petroleum fractions. As a result, in 1941 he accepted a position with the Shell Oil Company in Martinez, California. He soon became a senior engineer at the Shell Development Company in San Francisco. It was with Shell that Professor Hedrick realized the important role played by economics in the decisions of a major chemical company.

During the war, Dr. Hedrick was a consultant for the War Production Board. With the return to peacetime conditions, he was made an executive assistant of the Shell Chemical Corporation first at San Francisco and then at the New York offices.

It was at this point in his career that Professor Hedrick decided to come to Cornell. He had seen Cornell for the first time only eight months before coming here, but he liked the idea of settling down in a small university town. At Ithaca he would no longer have to move wherever his job took him. He became a full professor of chemical engineering and started teaching several of the chemical engineering courses. He then organized and began teaching the course in chemical engineering economics.

When asked about hobbies, Professor Hedrick replies that he has "too many." This is, of course, because of his busy schedule. However, in spite of his professional obligations, Professor Hedrick finds time for several non-professional interests. In his home he has a shop in which he builds furniture or "whatever my wife wants." He is interested in photography and gardening. Although he has less opportunity in Ithaca than he had in California, Professor Hedrick raises many varieties of flowers. He also remarks that he plays "lousy poker."

Professor Hedrick's classes are warm and informal. He encourages student participation in the discussions. Although asked by several publishers to write a book on chemical engineering economics, he prefers not to do so because he feels he would rely too heavily on it in his teaching. To keep the course flexible, Dr. Hedrick keeps only a broad outline of the content of his lectures. Any specific "lecture notes" that he may make, he discards after each lecture. In this way, each year's lecture is new and fresh.

Professor Hedrick served as an advisor to the ENGINEER for three years. He has also been faculty advisor to Tau Beta Pi and Alpha Chi Sigma. He belongs to the A.I.Ch.E. and the A.C.S. He is a member of Tau Beta Pi, Sigma Xi, Phi Lambda Upsilon, and Alpha Chi Sigma.

## PROFESSOR R. G. THORPE

In the fall of 1946, a young man applying for graduate work stood in the office of Professor F. H. Rhodes, Director of the School of Chemical and Metallurgical Engineering. Professor Rhodes asked of his secretary, "What do you think of this guy?"

She replied, "I think he has an honest face."

That was the start of Professor Raymond G. Thorpe's career at Cornell. Since then, he has been associated with Cornell as student, research investigator, and finally as associate professor of chemical engineering.

Professor Thorpe was born in Utica, New York, and grew up there in the Mohawk Valley. In 1942, he received his B.Chem.E. from Rensselaer Polytechnic Institute where he had been active as a member of the school tennis team.

With the start of World War II in 1941, Professor Thorpe was commissioned an Ensign in the Naval Reserve. The day after graduation he was called into active duty. He served in three theatres and four major campaigns, reaching the rank of Lieutenant. His final assignment was Assistant Gunnery Officer on the carrier Bennington.

When the war ended Professor Thorpe decided to continue his education in graduate school. His wife, a native of Cortland, suggested Cornell. Professor Thorpe recalls that he "didn't care much about Cornell and wanted to go back to RPI." Fortunately, he did apply for admission to Cornell and was accepted in the rather interesting manner already mentioned. He received his M. Chem.E. in 1947.

After graduation Professor Thorpe worked as a research engineer in the Plastics Division of the Monsanto Chemical Company at Springfield, Massachusetts.

In the Navy, Professor Thorpe had realized the importance of teaching. As an officer he had been called upon to train men, encourage them to work for promotions and finally to pass on these promotions. He had always admired Professor Briggs, then of Cornell's chemistry department. At this point, Professor Thorpe decided that he wanted teaching as a career, and in 1949 he accepted a position as a research investigator at Cornell.

For three years Professor Thorpe did research work, much of it on the high-temperature properties of steelmolding sands. In 1951 he began to teach metallurgical engineering courses and in 1953, chemical engineering courses. Now all his teaching is in chemical engineering.

Professor Thorpe is married and has a son, Mark, who is four. Even though he is busy within the University, he still has some time for other interests. He recently built an addition to his house. However, since this was a little bigger job than he had bargained for, Professor Thorpe says that he has since confined his interests to smaller projects, mainly photography.

Professor Thorpe is a member of many professional societies. Among these are: Tau Beta Pi, Sigma Xi, the American Chemical Society, and the American Foundrymen's Society. He has been a faculty advisor to Alpha Chi Sigma and has recently become one of the advisors to the ENGINEER.

Professor Thorpe has had papers published on his work on molding sands and also in the field of plastics. He has definite plans to write a textbook with Professor Winding for the sophomore Introductory Chemical Engineering course.

Professor Thorpe has a genuine interest in people. He is constantly striving for closer student-faculty relations. Anyone who knows him is familiar with his warm personality and sharp wit. He has become a familiar and popular figure about Olin Hall, and with his real interest in teaching, he will be so for many years to come.

## COLLEGE NEWS

*(Continued from page 42)*

### NEW MATHEMATICS PROGRAM

The Cornell mathematics department is trying a possible solution to the problem of teaching freshmen who have vastly different interests and backgrounds in the subject.

At the beginning of the school year, the department divides its first-year calculus students into three groups, on the basis of their college aptitude test scores. Any necessary shifts are made after three weeks.

The new program allows better equipped students to move faster than before, according to Prof. R. J. Walker, department chairman, and students with less preparation to get more help. It indicates no lowering of academic standards, he explained.

The thousand-odd students who register for first-year calculus are placed in 50 class sections of about 20 students each. Ten sections receive a course that covers more material and theory than the former first-year course. After the first term, 20 of these students are transferred to a special section that covers even more ground.

The great majority (40 sections of the 50) receive a typical calculus course meeting three hours a week, but ten of these sections receive an extra hour of class work each week without college credit.

Most of the students in the advanced sections are majoring in mathematics or in subjects like chemistry, physics or engineering, where the helpfulness of mathematical competence is universally recognized. Relatively few other students have the preparation and competence for these sections.

Since some students have better high school preparation in mathematics than others, a score on mathematical aptitude alone does not tell which section a student belongs in. Verbal aptitude scores are always considered too.

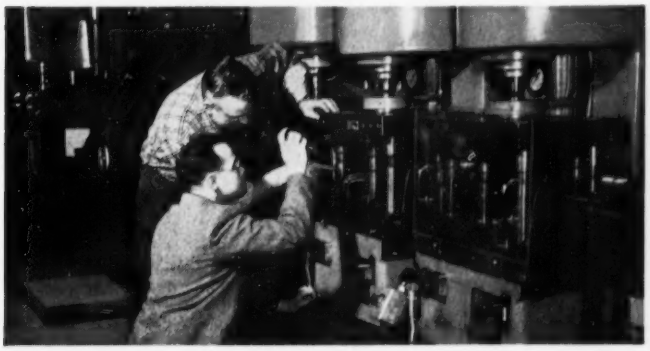
An entering freshman with a good mathematics score and a high grade in verbal expression for instance, usually goes into the more difficult calculus course, while a student with an equal mathematics score but a low verbal aptitude grade does not.

# Meet Dick Foster

## *Western Electric development engineer*

**Dick Foster joined Western Electric,** *the manufacturing and supply unit of the Bell System, in February 1952, shortly after earning his B. S. in mechanical engineering at the University of Illinois. As a development engineer on a new automation process Dick first worked at the Hawthorne Works in Chicago. Later, he moved to the Montgomery plant at Aurora, Illinois where he is pictured above driving into the parking area.*

**Dick's day may begin** *in one of several ways: an informal office chat with his boss, a department "brain session" to tackle a particularly tough engineering problem (above); working with skilled machine builders in the mechanical development laboratory; or "on the line" (below) where he checks performance and quality and looks for new ways to do things.*



**Here Dick and a set-up man check over** *the automatic production line used to manufacture a wire spring relay part for complex telephone switching equipment. This automatic line carries a component of the relay on a reciprocating conveyor through as many as nine different and very precise operations—such as percussive welding in which small block contacts of palladium are attached to the tips of wires to within a tolerance of ± .002".*

**Examining the plastic molded "comb"** *components of the wire spring relay Dick recalls his early work when he was involved in working-up forming and coining tools for the pilot model of the automation line for fabrication of wire spring sub-assemblies for relays. At present he is associated with the expansion of these automation lines at the Montgomery Plant.*

**Dick finds time** *for many Western Electric employee activities. Here he is scoring up a spare while tuning up for the engineers' bowling league. He is active also in the golf club, camera club, and a professional engineering society. Dick, an Army veteran, keeps bachelor quarters in suburban Chicago where he is able to enjoy the outdoor life as well as the advantages of the city.*

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*"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."*

## ENGINEERS AS TEACHERS

One of the most satisfying experiences for any human being is to earn the unqualified admiration and affection of others. Add to this the personal realization that you have greatly influenced the character, ambition and destiny of many of your fellow men. It is deeply rewarding to convey sincerity, enthusiasm, devotion to duty and a code of ethics to others so that instead of one you are many leaders—in religion and morals, science and industry, history and government.

A big order—an impossible task? Not at all, it is easily attainable through teaching. How many of you, both graduate and undergraduate of Cornell Engineering have given serious consideration to a teaching career? Probably not many—but you are missing a terrific opportunity.

True, the financial reward may not be great, but that is the least consideration. You don't believe so—well, take your choice: place yourself on two deathbeds. In one, you are surrounded by the ultimate in luxury, the best medical attention—but you are *alone*. In the second, you are surrounded by friends and former students and are happy in the full realization that the real important part of you will live on in them and grow through them to succeeding generations.

True, the professional recognition of the teacher leaves much to be desired in our country. But this will change, probably within the next generation. America is approaching maturity as a nation. This, together with the results of our experiment with mass education, will bring about the desired recognition. As a good teacher today you can help in the earlier realization of this objective.

Teaching has many other advantages: long vacations to do the many things you will never be able to do in any other field of science and engineering; steady employment independent of business cycles; more time with your family and friends all through your life.

Better teaching for engineers is an essential first step in improving their professional status and in fostering continuing technical progress. Consider teaching as an important alternative in your choice of an engineering career.

Walter L. Hardy
*President*

# ALUMNI ENGINEERS

**William L. Everitt, B.S. in E.E. '21,** is dean of the college of engineering at the University of Illinois. A distinguished electrical engineer and educator, he was elected president of the American Society for Engineering Education at its 64th meeting held in June. This was in recognition, among other things, of his leadership in the Society's effort to increase the basic science content of engineering curricula. He has had a varied and full background. He served as an instructor in E.E. on the Campus from 1920-22. After two years as engineer for North Electric Manufacturing Co. in charge of automatic P.B.X. development, he then entered education going to the University of Michigan as instructor. He became assistant professor at Ohio State University in 1926. He then went to the University of Illinois where he eventually rose to the position he now holds.

He has written "Communications Engineering," a widely used text and edited the thirty volume Electrical Engineering series.

**Frank Wolsheimer, B.S. in C.E. '35,** is president of Llenroc Engineering Services.

**William G. Whitney, B.S. in A.E. '44,** has been elected assistant vice-president, planning, of American Airlines. He joined the airline two years ago and before his promotion was director of planning. He is the son of the late **William N. Whitney '12.** Address: 32 Fremont Road, North Tarrytown.

**John S. Osborne, B.M.E. '48,** 264 Academy Drive, Vestal, is an associate engineer with International Business Machines Corp. June 5, he and Mrs. Osborne became the parents of a son, John Norman. The baby joins an older sister, Carolyn, 2.

**Si Chiu Lou, M.M.E. '50,** is an engineer with Bechtel Corp., San Francisco, Cal. He is married and has one daughter, Lily Joan. Address: 2908 Deakin Street, Apartment D, Berkeley 5, Cal.

**Alex J. Kopczynski, B.C.E. '43,** is a resident engineer with the New York State Department of Public Works in Allegany County. He lives in Friendship.

**Alison King, B.Arch. '44, '48,** is an architect with the firm of Compton & Pierce, Cambridge, Mass., where she lives at 336 Harvard Street. Last July she was on a concert tour through Germany with the M.I.T. Choral Society, of which she has been a member for the last three years.

**Edgar H. Dix, Jr., M.M.E. '16,** assistant director of research at the Aluminum Research Laboratories of the Aluminum Company of America, Pittsburgh, is 1956 winner of the Albert Sauveur Achievement Award, presented by the American Society for Metals.

The award, established by the A.S.M. in 1934 for pioneering work in metallurgy, is named in honor of Dr. Albert Sauveur, late Harvard University Professor and the metallographist who produced the first photomicrographs of steel made in the U.S.

Dix will receive the engraved plaque award recognizing his outstanding work in aluminum alloys research at the American Society for Metals' annual banquet on Thursday night, Oct. 11 in Hotel Statler.

The award winner has been associated with Alcoa since 1923. He received his M.E. Degree in 1914 and his M.M.E. in 1916 from Cornell, began his research on aluminum alloys in 1919 as assistant engineer of tests for Aluminum Casting Co. and continued in 1921 as chief of the Metals Branch, Engineering Division, Air Service, McCook Field.

Dix was chairman of the Pittsburgh Chapter of the A.S.M. in 1931-32 and on the A.S.M. Publications Committee, 1940-43. Other technical society affiliations include: American Institute of Mining, Metallurgical and Petroleum Engineers (Chairman, Pittsburgh Section, 1935-37); chairman, Institute of Metals Division, 1936-37, Institute of Metals Division Lecturer, 1940; Society of Automotive Engineers; and British Institute of Metals.

**H. A. Parker, B.S. in Ch.E. '44,** former technical director of the Destrehan, La., refinery of American Oil Company, has been promoted to the new position of assistant manager of operations of the company.

Mr. Parker, who was born in Tulsa, Okla., was graduated from a five-year course in chemical engineering in 1944 at Cornell University where he played varsity basketball and baseball. He entered the oil industry the same year as a process design engineer in the research department of the Whiting, Ind., refinery of Standard Oil Company (Indiana), parent company of American Oil Company. After being promoted to a group leader in process design in 1946, Mr. Parker was transferred to Pan-Am Southern Corporation's Destrehan, La., refinery as technical director in 1951.

**Charles Peek, B.S. in M.E. '49,** was recently appointed assistant project engineer for Pratt & Whitney Aircraft.

**E. C. Sargent, B.S. in Ch.E.,** was recently appointed President of the Zirconium Corporation of America in Solon, Ohio.

Sargent, who joined the Ohio firm in February as vice president and general manager succeeds Mr. N. V. Coyle who remains as chairman of the board.

He brings extensive administrative and technical experience to his new post as head of Zircoa, which specializes in production of Monoclinic and Stabilized Zirconium Oxide and custom molded Zirconia shapes.

A native of St. Paul, Minnesota, Sargent was formerly Project Manager for the Vitro Engineering Division, Vitro Corporation of America, and served from 1949 to 1952 as Cleveland Area manager for the Atomic Energy Commission.

In addition to his wide experience in atomic energy and industrial chemistry, Sargent also founded and is currently a director of Radiation Application, Inc., a new York consulting firm.

He holds a Bachelor of Chemical Engineering Degree from Cornell University and served for four years during World War II as a pilot in the naval Air Corps.

Mr. Sargent lives with his wife and four sons in Aurora, Ohio.

**John N. Boyle, '42,** who formerly headed test work for General Electric Company's Ordnance Department, has been named superintendent of manufacturing in the Atomic Power Equipment Department.

An employee of General Electric since 1942, Mr. Boyle formerly was assistant general foreman for Aircraft and Ordnance Systems Divisions test activities.

A native of New York City, Mr. Boyle earned a bachelor of science degree in engineering from Cornell University in 1942.

# "A new era is beginning...

"As I review the progress in aeronautics within so short a span, and marvel at the complex aircraft of today, I call it an achievement little short of miraculous.

"Today, electronically-guided planes take off and land without human touch. Lethal sky missiles seek and destroy invisible targets with uncanny precision. And still other fantastic achievements in both man-controlled and pilotless flight are now in the offing.

"When men go to the moon and planets, electronically-controlled skycraft will take them there. Aviation maps will be studded with stars as well as with cities. New developments in aeronautics will go on and on. Success opportunities and careers will continue to develop for ambitious young men in this exciting field where a new era is beginning."*

LEE De FOREST

Appropriately qualified to speak for aeronautics and other fields in which his own scientific achievements play an important part, Dr. Lee de Forest gives helpful counsel to young graduates headed for successful, rewarding careers.

His expression, "a new era is beginning," has particular significance at Northrop, world leader in the design, development and production of all-weather and pilotless aircraft.

At Northrop, permanent positions are available that offer full play for individual talent and ambition. Here the graduate engineer will find interesting assignments for which he is best fitted. Surroundings are attractive, co-workers congenial, opportunities for advancement unceasing, the compensation good.

*For detailed information regarding specific openings in your field of specialization, write Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., 1001 East Broadway, Hawthorne, California.*

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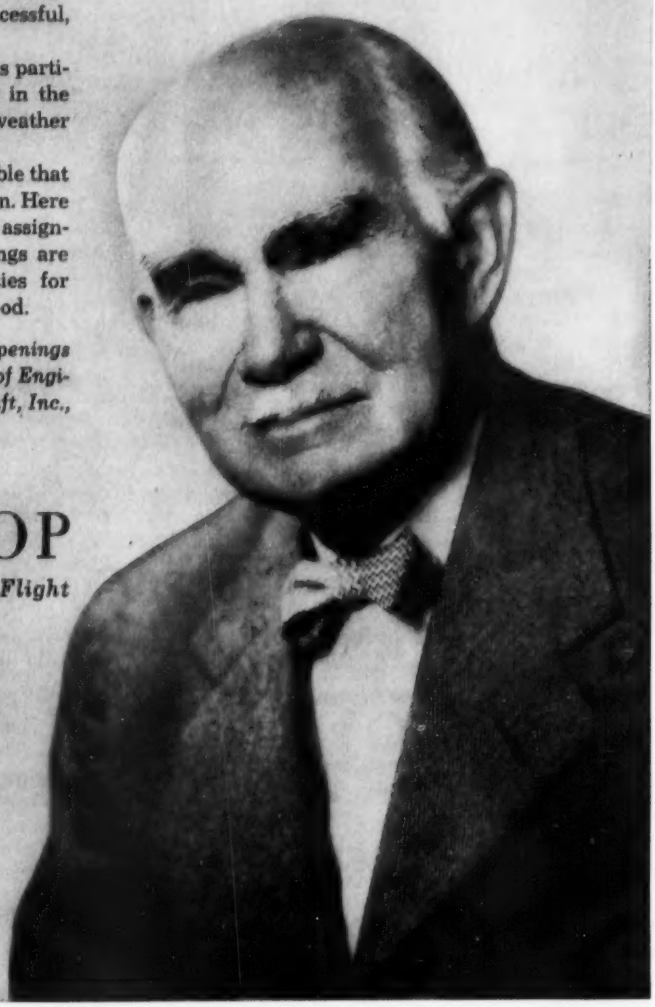


**A statement by Dr. Lee de Forest, pioneer in radio.*

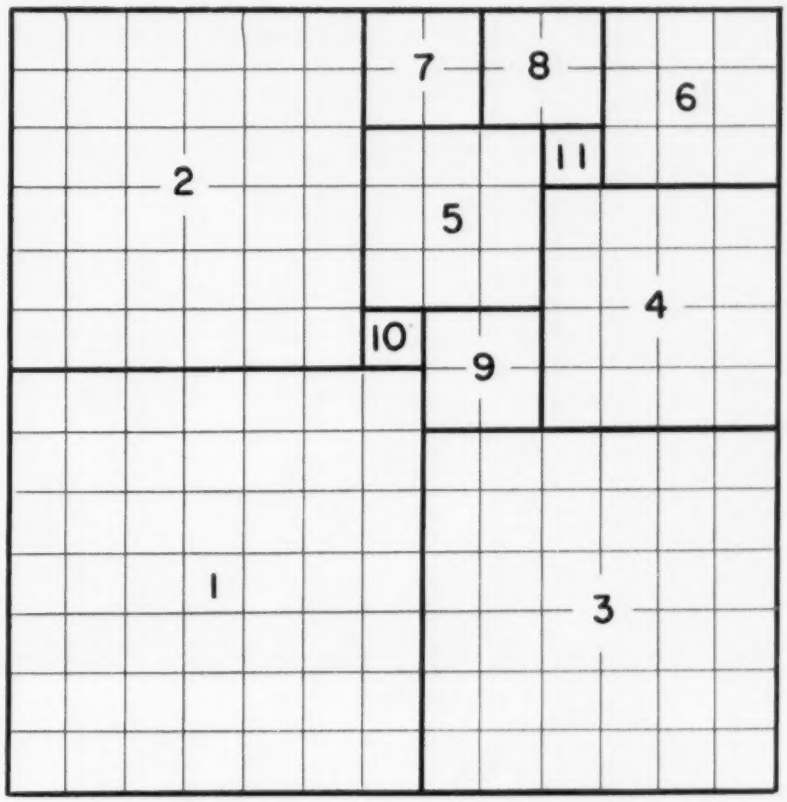
# BRAINTEASERS

*Problem 1.* A Cornell freshman decides to "dress up" the Arts Quad by stacking some cannon balls in front of Goldwin-Smith. He has 35 in all, spherical in shape and 4 inches in diameter. The freshman stacked them in the form of a triangular pyramid but decided to remove them because of their height. What was the height of the stack before the freshman took them down?

*Problem 2.* A Cornell student with his date decided to tour the campus. If their speed is four miles per hour on level land, three miles per hour up hill, and six miles per hour downhill, how far did they walk if they started at 7:00 P.M. and returned at 1:00 A.M.? (Distances traveled up hill and down hill equal on outbound and return trips.)

*Problem 3.* At a certain college town railroad station both east-bound and west-bound trains pass through at 30 minute intervals throughout the day and night. Yet if you go to this station at a random time, the odds are five to one that the first train which comes through after your arrival will be west-bound. How can this be so?

*Problem 4.* Express one-seventh as a repeating decimal in a number system whose base is three.




**Answer to Problem 4 for November**

## NOVEMBER ANSWERS

The following are answers to November Brain Teasers.

1. The party consisted of 2 girls and a boy, their father and mother, and their father's father and mother.

2. If the 65 minutes were counted on the face of the same watch the problem would be impossible for the hands must coincide every $65\frac{5}{11}$ minutes as shown by the watch and it makes no difference whether the watch runs fast or slow; but if it is measured by true time it gains $\frac{5}{11}$ of a minute every 65 minutes, or $\frac{60}{143}$ of a minute every hour.

3. The boy would have to travel 80,850 yards or $45\frac{15}{16}$ miles.

4. The diagram shows how Mrs. Smith should cut her quilt. The fewest separate squares will be 11.

## RIAS

*(Continued from page 34)*

istrative responsibilities, a scientist would have more opportunity for conducting a thorough, creative study than a college professor who is often limited by classes, funds, lack of equipment or personnel, etc. However, RIAS must solve many problems before it will be successful. At present many scientists are skeptical of industry's attempts to undertake basic research (often because they are unfamiliar with industry). Consequently RIAS has a problem of attracting top-level scientists. RIAS must also obtain contracts for conducting research from industry and the government if it is to be a self-sustaining corporation. The research institute must sell to the government and other industries the idea that fundamental research should be ordered and bought just like airplanes or cars. In time, when people gain a full understanding of the ideals and purposes of RIAS, the Company will be able to solve many of its present problems and should eventually become comparable to Princeton in its results.

# AVIATION

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## ETHICS & ENGINEERING

*(Continued from page 37)*

engineer is to learn about professional codes (ethical ones) it will clearly have to be in his college. . . . Engineering educators have thus accepted the obligation to teach their students ethical judgment."

How can the colleges instill engineering ethics? By proper planning and effective re-evaluation, a program can be put forth to acquaint students with engineering ethics.

This plan might include:

1—An Honor System, regarding all examinations and reports. This increases individual ethics and also creates a professional atmosphere. When people collaborate while writing a report, proper recognition is given to all sources of information. A group feeling is created, one of trust in your fellow men. The honor system has worked in many colleges. The School of Civil Engineering at Cornell has had one for over fifty years. Proctors are not allowed in the examination room. Subsequently, those who violate the code are reported and judged by fellow students. The signature after "I pledge," made during the examination, means that the student pledges, on his honor, that he has neither given nor received aid during the examination.

2—Teaching courses in engineering ethics. This can accomplish much, provided a proper incentive for learning is acquired by the student. The professor who teaches this course will have to be dynamic. He must motivate the student to inquire and learn about engineering ethics. Too often the general feeling of the student is, "Who cares, it's just another liberal arts course."

3—Creating a professional atmosphere by each faculty member. This is an excellent idea, provided it is carried out in a proper manner. Faculty members should have a positive approach in carrying out their responsibilities of advising students and student groups in their endeavors.

4—Booklets should be distributed to all students telling about the relationship between the engineering profession and engineering ethics. Let the student know what the "Canons of Ethics" and "The Faith of The Engineer" are. Must all students use their own initiative to find these things?

5—Ethics should be discussed at junior society meetings. Here all points of view may be integrated so that the student might be adequately informed on this subject.

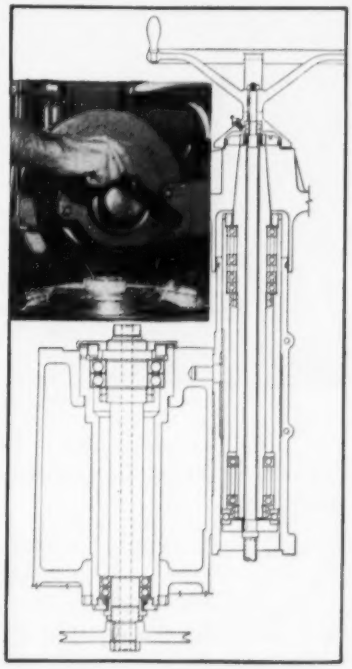
If the above program is carried out the student will graduate from college with more than a degree. He will have a clear conception of what his profession is, what it expects of him, and how he must act.

The professional man must be not only equipped to solve technical problems, but he must develop a necessary awareness of the problems confronting the individual in society. His background must include more than a mere smattering of humanities. It must give him a new outlook, where he can go beyond systematic knowledge, where his imagination and reasoning play an important role and where his judgment must be exercised. He must be taught to cope with problems where there is not just one right answer.

After graduation, the engineer finds himself in a world of many engineering societies. Instead of finding one strong effective organization he finds over one hundred small ineffective groups. Though we have over eighty societies, which have adopted the "Canons," each enforces it in different degrees and in a different manner. We need one society to effectively enforce these rules.

If we had one society to unify the engineering profession, many of the problems in engineering ethics would dissolve themselves. This group could do much to end the monetary plight of some of our engineers. It could combine many of the excellent points of professional unions and apply it throughout industry. More tactful methods than collective bargaining could be used.

*(Continued on page 70)*

**How a precision grinder holds its precision—for years**

**In pre-loading super-precision ball bearings, a precision surface grinder is used for close-tolerance grinding of bearing ring faces (see photo). In the grinder diagrammed here, moving parts are mounted on Fafnir ball bearings to assure the absolute rigidity essential for this exacting work.**

**All bearings indicated, except the thrust bearings at the bottom of the column supporting the wheelhead arm, are Fafnir pre-loaded, super-precision types. The oscillating wheelhead is similarly mounted. Original bearings in column and workhead have been in operation and have maintained their precision for over 15 years.**

**A long history of such successful bearing applications is a big reason why engineers throughout industry look to Fafnir for help with special bearing problems. The Fafnir Bearing Company, New Britain, Conn. (23 Branch Offices)**

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*An interesting aspect of an engineering career with Fafnir is the opportunity for first-hand observation of Fafnir products actually on-the-job in Fafnir plants. Fafnir bearings are widely used in equipment necessary for bearing manufacture, including machines such as the precision surface grinder above.*

*The opportunity for on-the-job evaluation of bearing performance is invaluable as a source of information — and, often, inspiration — in the vital, diversified work of designing, developing, and assisting in the application of bearings for all of industry. Perhaps Fafnir offers you the challenges and satisfactions you want in engineering, or sales engineering. We'd be glad to hear from you.*

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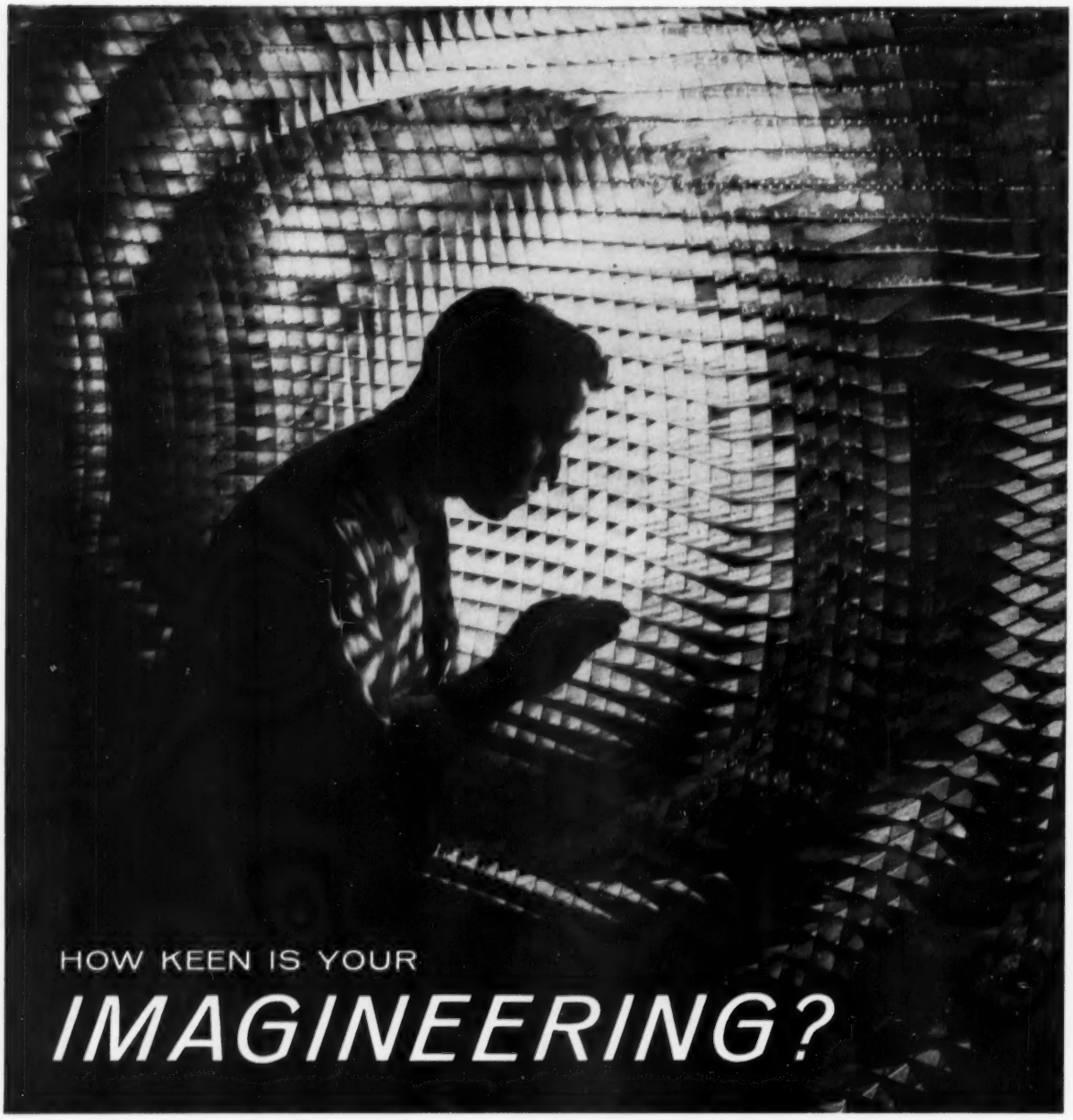


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■ Whether you elect to work with Sperry in its modern plant in Long Island, or in Florida, California, Virginia or Utah, there is a bright future for you at Sperry, and one limited only by your own desire to get ahead.

■ Check your Placement Office for dates when Sperry representatives will visit your school. Make it "a must" to talk with them or write J. W. Dwyer, Sperry Gyroscope Company, Section 1B5.

*P.S.* In case you *didn't* identify the equipment shown above, it is part of an 8 ft. Sperry-designed radar antenna for long range missile guidance.

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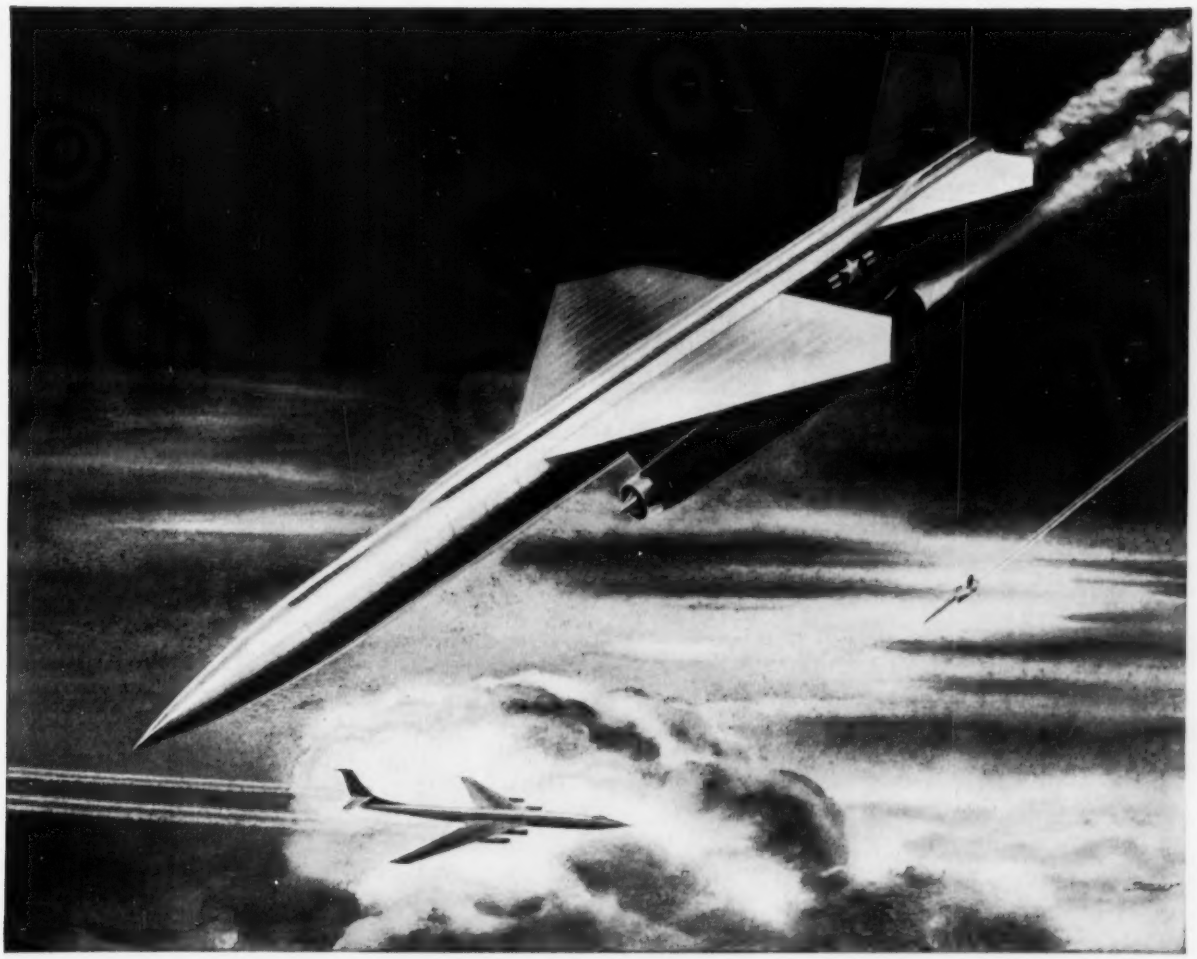

## Boeing research produces a new defense weapons system

Boeing's BOMARC IM-99 is a long-range guided missile designed to strike enemy bombers while still over areas away from vital targets. It's a supersonic spearhead of an entire defense weapons system that includes communications, bases, logistics.

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Series of Decisions Which Led to Announcement Of Parlin Plant for Polyethylenes Detailed; Forster's Picture Is on Front Cover
HERCULES WILL BUILD $10,000,000 PLASTICS PLANT AT PARLIN, N. J.
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# A CHEMICAL HEADLINE MAKER OFFERS CAREERS WITH A FUTURE

When the editors of the nation's business press devote cover stories to a company, it's a good sign that the company is setting a fast pace in today's competitive world. By branching off into new fields of creative chemistry, by building its sales from $7,000,000 in 1913 to more than $226,000,000 in 1955, Hercules Powder Company was one of the big stories of 1955. With an investment of more than $28,000,000 going into new plant facilities this year alone Hercules will continue to be a growth leader in the years ahead. This is the type of company in which ability finds its opportunity for advancement; where a young man can grow into the type of job he will find most rewarding. Why not find out more about careers with Hercules from your placement officer? Or write direct to Hercules for additional information.

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## CARTONS

*(Continued from page 18)*

understandably, a great deal of waste paper. The largest amount of waste comes from the trimming operations of the corrugator and the slotting operation of the printer-slotter. In most corrugated plants, fans suck the waste cuttings through large metal tubes. The cuttings are carried through the tubes to a baling machine where they are compressed into large bales and bound by metal wire or straps. The bales are sold, minimizing the monetary loss from waste.

Most industries find that the corrugated carton alone provides enough protection for the products they plan to ship. Some concerns, however, find that they need additional corrugated accessories in order to insure the safe arrival of their goods. Those companies that bottle or can their products require partitions in their cartons, while other companies desire pads to separate one layer of a carton's contents from another. Occasionally a company desires a corrugated sheet to line the entire carton.

The making of the separate parts for partitions is not a difficult process and is usually done on a partition slotter. This is a hopper-fed machine with revolving knives that cut ¼-inch slots. The assembling of the partitions is, however, a very difficult operation. Until recently it was necessary to employ workmen who would do nothing but assemble partitions. Needless to say, this method of operation proved very costly and time consuming. There are now on the market several types of machines for the assembly of partitions.

A common type of partition assembler involves the placing of the various pieces that will make up the partition in different stacks—the number of stacks depending on the number of compartments that the final partitions is to have. These pieces are then kicked into metal fingers mounted on a wheel which turns allowing a second set of panels to be kicked into a set of fingers which are now parallel to the kickers but perpendicular to the first set of panels inserted. The wheel again turns ejecting the completed partition at one point while another is being assembled at a different position. The assembled partitions are tied together; thus, ready to be shipped.

The manufacture of corrugated pads is a comparatively simple operation. If the pad is large enough it can be cut right on the corrugator. Usually, however, the pad is too small to be cut on the corrugator and must be cut from a much larger sheet. In order for the sheet to be cut, it must be sent to the partition-slotter, which is capable of cutting pads as well as parts for partitions. If the pad is of an unusual shape, a die-cutter must be used. In this machine, a cutting die is placed on a moving jaw while the sheet to be cut is placed by hand on a lower stationary jaw. The upper jaw brings the die to the sheet where it is cut. The die-cutter may be used to cut any impression desired into a corrugated sheet. Through the use of this piece of equipment, anything from a corrugated play house to a corrugated valise may be manufactured.

### New Developments

The corrugated container industry is constantly changing. Not only are new types of paper being developed to give better cartons, but the cartons, themselves, are undergoing new processes to give them more desirable qualities. Among the newer type of cartons available are waterproof corrugated boxes that can preserve their contents in ocean water for several days. Changes, too, are being made in the type of corrugation used. Flutes of different height and style are constantly being experimented with in order to improve the strength of the carton.

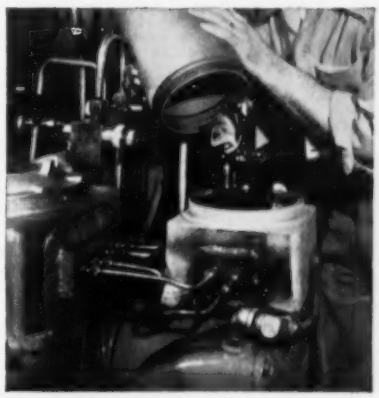
The use of the corrugated sheet for items other than cartons has proved to have many possibilities. Corrugated sheets are being fashioned into inexpensive window displays, closets, play houses, and have even been considered for use as temporary army barracks. Through further research, the corrugated carton may, in the near future, serve many purposes other than that of industry's cargo carrier.

### Sources

Kraft Corrugated Containers; Bayonne, N.J.
Universal Corrugated Box Machinery Corp.; Linden, N.J.
A. W. Werner, "The Manufacture of Fibre Shipping Containers."

*An idea to build your future*

**How Denison hydraulic equipment**



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The system functions in this manner. An analog computer takes the place of the jet engine. Performance data and other characteristics are received from the manufacturer. These are simulated on the computer and reproduced as electrical signals and, in turn, run the engine controls.

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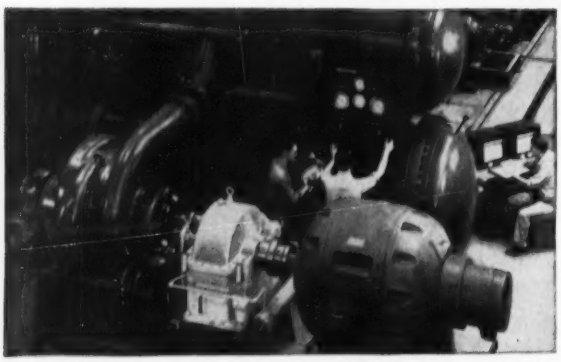

**COMPREHENSIVE TESTS** are run on a Worthington centrifugal refrigeration unit (lower left) now in service as one of the Arabian American Oil Company's central air conditioning units in Dhahran, Saudi Arabia.

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## LOW TEMPERATURES

*(Continued from page 23)*

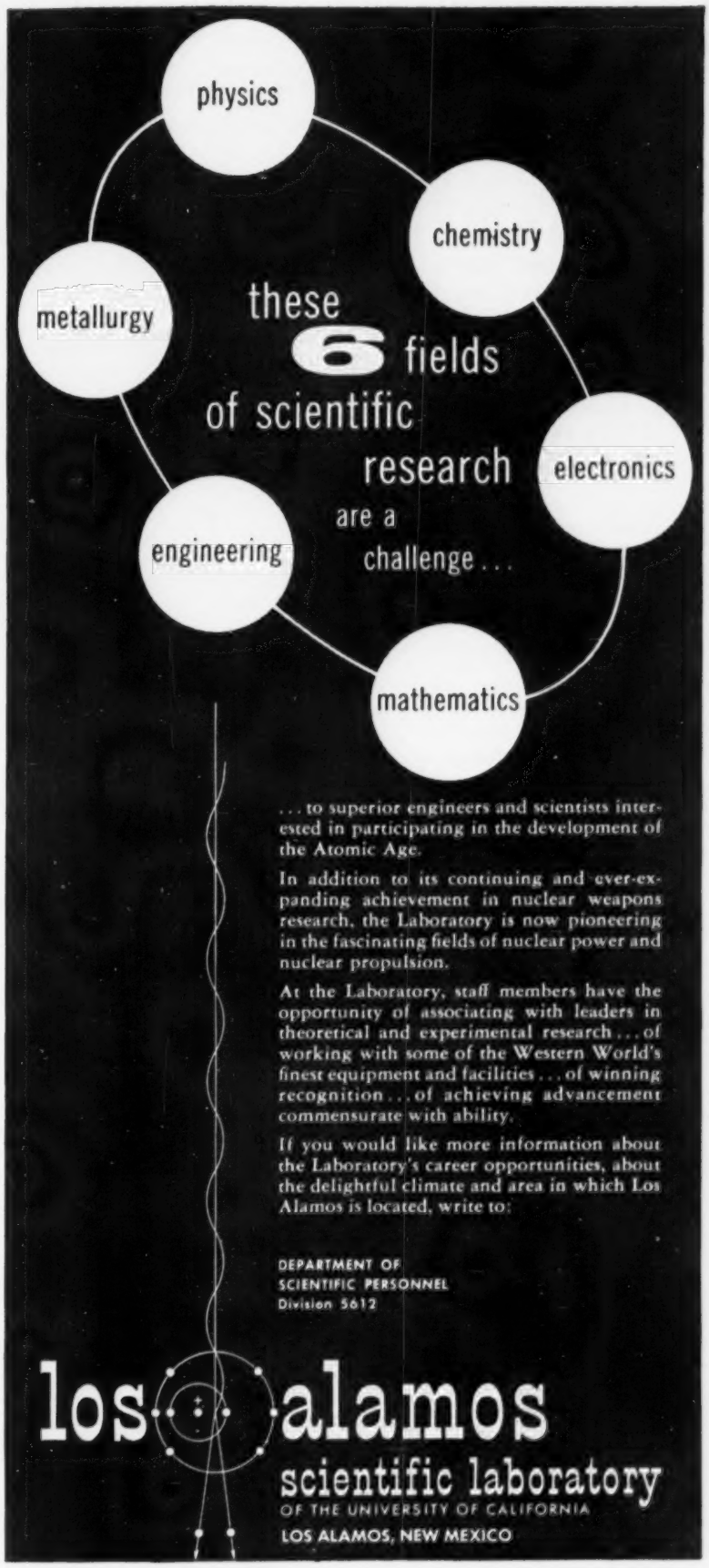
like a tuning fork at the natural frequency of the specimen. The rate of decay of the vibrations will then depend on the internal friction of the specimen. The movement of the specimen is measured by mounting an electrode near it and using the capacitor formed by the electrode and the specimen to frequency modulate a radio-frequency oscillator.

One more experiment seeks to investigate heat conductivity in germanium crystals and to investigate the effects of impurities. In this experiment, a steady-state heat flow is set up in the crystal between a heater and a copper block at constant temperature. The temperature along the germanium crystal is measured by resistance thermometers or thermistors. The experiment is being done at various temperatures with germanium containing from zero to ten per cent silicon.

Other experiments include a study of the thermal conductivity of potassium chloride. At extremely low temperatures, potassium chloride becomes a better heat conductor than copper at normal temperatures. A study is also being made of the dielectric properties of phosphors.

Many other interesting effects are observed when temperature vibrations of substances are decreased almost to the vanishing point. Superconductivity is one of the outstanding phenomena. There are a number of metals, such as mercury, tin, lead, aluminum, and zinc, which, at a certain temperature, lose all measurable electrical resistance. A sheet of such a metal would be an effective screen against magnetism, and a current induced in a ring made of it would theoretically continue flowing indefinitely.

The low temperature research being carried on at Cornell is an attempt to find out more about the behavior of matter when molecular motion is slowed almost to a standstill at temperatures approaching absolute zero.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*Another page for* **YOUR STEEL NOTEBOOK**

## How to shape a vacuum cleaner like a basketball

TO make their new vacuum cleaner functional as well as handsome, engineers at the Hoover Company developed a nearly round design. The problem was how to produce it economically.

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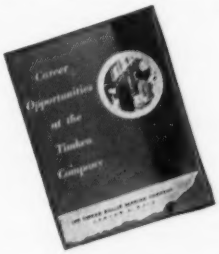
After studying the problem, Timken Company metallurgists recommended a special analysis of tool steel for the dies. Graph-Mo®, developed by the Timken Company. Minute particles of graphite in Graph-Mo act as a built-in lubricant—keep parts from galling. Diamond-hard carbides in its structure make it wear, give it longer life.

With the new Graph-Mo dies, downtime was cut 50%. Production rolled smoothly. The dies outlasted previous ones 3 to 1. It's another example of how Timken pioneering in fine alloy steels helps solve knotty industrial problems.

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## ETHICS & ENGINEERING

*(Continued from page 61)*

The survival rate of engineering firms would increase because this society would create the necessary professional attitude of its members—that of helping your fellow men, not for personal gain, but for the public's benefit. Thus, competitive bidding, laudatory advertising, and kickbacks and bribes would be a product of the past. These things could not occur in a harmonious professional group that could take immediate and effective action against violators of its codes. The Engineering Council for Professional Development should be this group.

Two main conclusions have been reached to combat the problems facing our profession:

1—The engineering colleges must play a greater role in acquainting the student with his profession and its ethics.

2—There should be one unifying professional group, powerful enough to enforce its rules of conduct, which the engineering graduate can join.

If these recommendations are carried out it will be just the beginning of a fight, to put the engineering profession on the same basis as the medical profession in the eyes of the engineer and the public.

If each of us could realize what problems face our profession, we would be in a much better position to solve them. If each of us read the "Canons of Ethics" and tried to interpret it in his own light, much would be accomplished in obtaining engineering ethics. If each of us read "The Faith of The Engineer" and aspired to follow its concepts, engineering would be a profession that would be envied by every other group. It is up to us to follow and enforce these rules.

Much of this discussion has been highly idealized. The answers to many questions were that we needed more people who would sincerely abide by our codes of ethics. But the problem remains as to how can we accomplish this. If the suggestions, previously made, are carried out, we will be on our way to making engineering an ethical profession. Once the spark is generated, flames will burst and the necessary leadership to carry out effective ethical and professional programs will emerge. Let us hope that our generation will see the rapid upward movement of the engineering profession.

---

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## TECHNIBRIEFS

*(Continued from page 47)*

The new product, which can be supplied in any standard color, can be utilized for manufacturing many parts which heretofore required protective or decorative finishing after fabrication, such as, automotive panels, radio and television cabinets, institutional and office furniture, appliances, kitchens, wall panels, etc. Elimination of the need for such post-fabrication treatment, coupled with the unique properties of the new coated sheet, will result in lower production costs, together

with superior wearing qualities and decorative effects.

At present, due to the developmental nature of the operation, no definite annual production capacities have been established. The pilot-line facilities will produce 18- to 28-gage sheets 24 to 52 inches wide. The semi-commercial product is being offered for sale on a developmental basis.

Cold-reduced sheets are coated with liquid plastic to produce an appealing, tough-surfaced sheet of great beauty and durability. It promises new decorative effects and long service in such equipment as refrigerators, radio and TV cabinets, wall panels, automotive bodies and trim, stove and heater parts, railroad coach, club and sleeping car interiors, office and home furniture.

In the process of manufacturing, the steel is surface treated to improve its bonding qualities, a specially compounded adhesive is applied to the top surface and then cured by heating.

After air cooling, the steel enters a coating chamber where the thermo-responsive vinyl plastic is applied to the adhesive-coated surface. Again, heat is applied to solidify the plastic. Prior to cooling, the vinyl coating is embossed to obtain the desired design or texture. The finished product is stacked by a magnetic piler.

The coating of this new material has excellent abrasion resistance and good electrical resistance properties. It is unaffected by humidity and many chemicals. The coating also produces sound-deadening effects similar to that obtained by "muffle coating" automobile bodies and will have value in acoustical design.

**PHOTO CREDITS**

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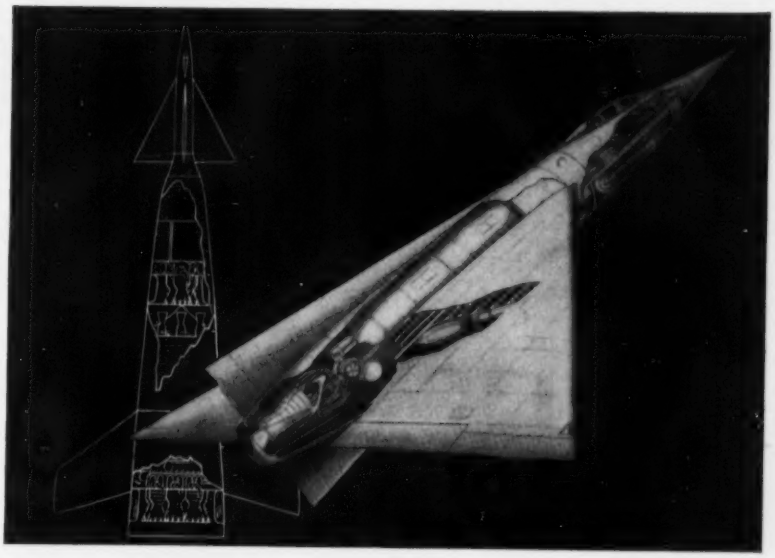
**MARS outstanding design SERIES**

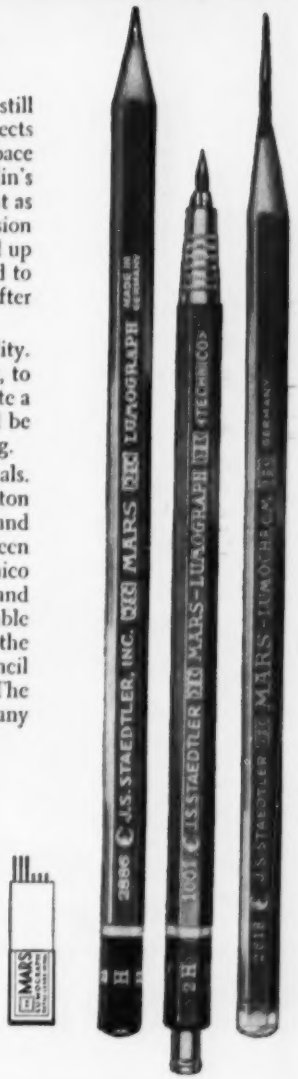


# 3 stages to space

The designs that will make news tomorrow are still in the "bright idea" stage today—or perhaps projects under development like this three-stage, two-man space ship. Drawn by Fred L. Wolff for Martin Caidin's "Worlds in Space," the rocket craft would start out as shown in the reverse drawing at left, shed its propulsion boosters in two stages as fuel is exhausted, and end up as the trim plane-like ship at right. Ship is planned to orbit a hundred miles above earth, return safely after one to two days.

No one knows what ideas will flower into reality. But it will be important in the future, as it is now, to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.




The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

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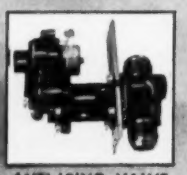
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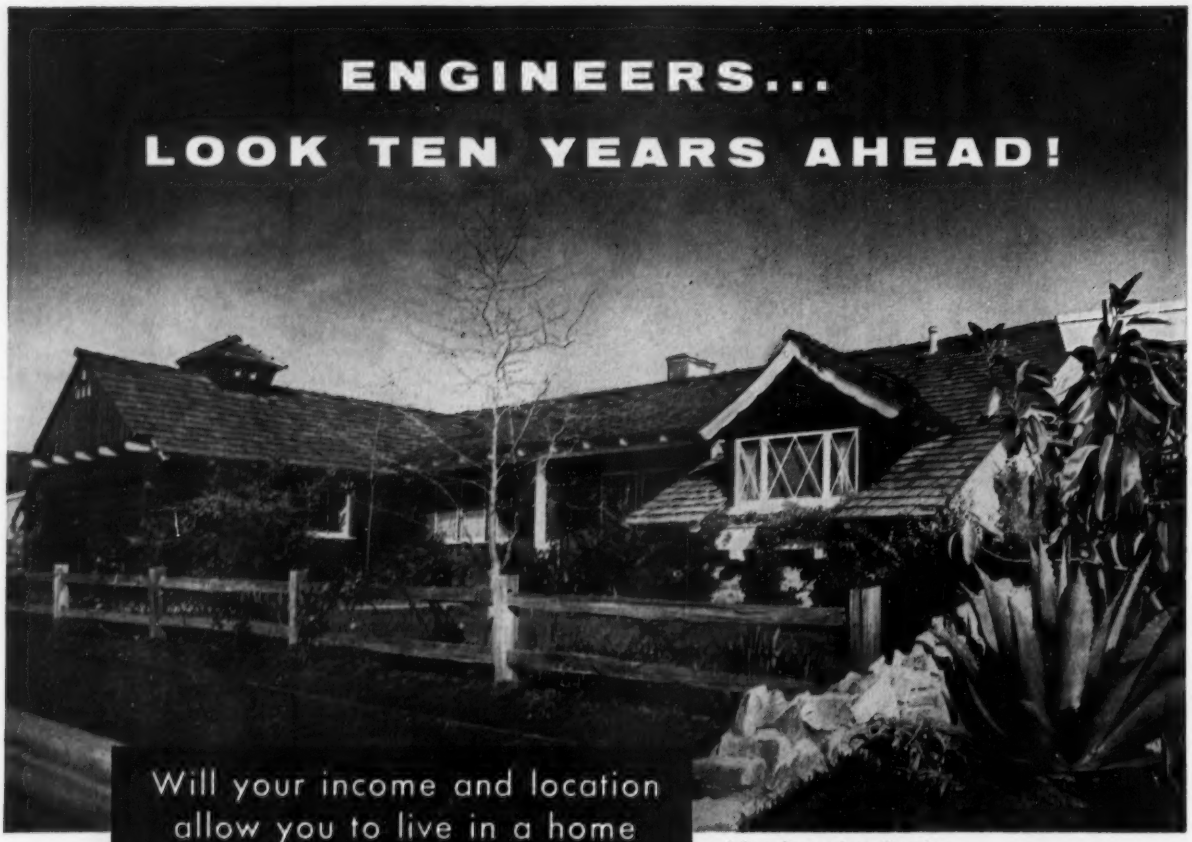

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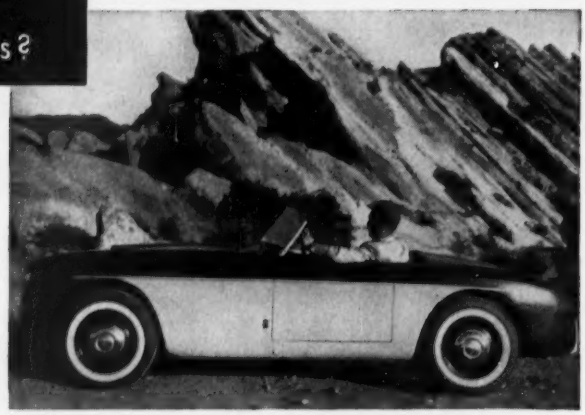

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The original machine had a baseplate of prefabulated amulite, surmounted by a malleable logarithmic casing in such a way that the two spurving bearings were in a direct line with the pentametric fan. The latter consisted simply of six hydrocoptic marzelvanes, so fitted to the ambifacient lunar waneshaft that side fumbling was effectively prevented. The main winding was of the normal lotus-o-delta type placed in panendermic semi-boloid slots in the stator, every seventh conductor being connected by a non-reversible tremie pipe to the differential girdlespring on the "up" end of the grammeters.

Forty-one manestically spaced grouting brushes were arranged to feed into the rotor slip-stream a mixture of high S-valve phenyhydrobenzamine and five per cent reminative tetryliodohexamine. Both of these liquids have specific pericosities given by $P=2.5C_n$ where n is the diathetical evolute of retrograde temperature phase disposition and C is Cholmondeley's annular grillage coefficient. Initially, n was measured with the aid of a metapolar refractive pilfrometer (for a description of this ingenious instrument, see L. E. Rumpelverstein in "Zeitschrift fur Elektrotechnistiatischs-Donnerblitze," vol. vii.), but up to the present date nothing has been found to equal the transcendental hopper dadoscope (see "Prological Sciences," June, 1914).

Electrical engineers will appreciate the difficulty of nubing together a regurgitative purwell and a supramitive wennelsprocket. Indeed, this proved to be a stumbling block to further development until, in 1942, it was found that the use of anhydrous nangling pins enabled a kyptonastic bolling shim to be tankered.

The early attempts to construct a sufficiently robust spiral decommutator failed largely because of a lack of appreciation of the large quasi-piestic stresses in the gremlin studs; the latter were specially designed to hold the roffit bars to the spamshaft. When, however, it was discovered that wending could be prevented by a simple addition to the living sockets almost perfect running was secured.

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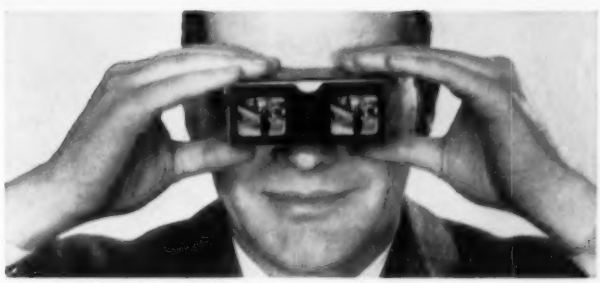

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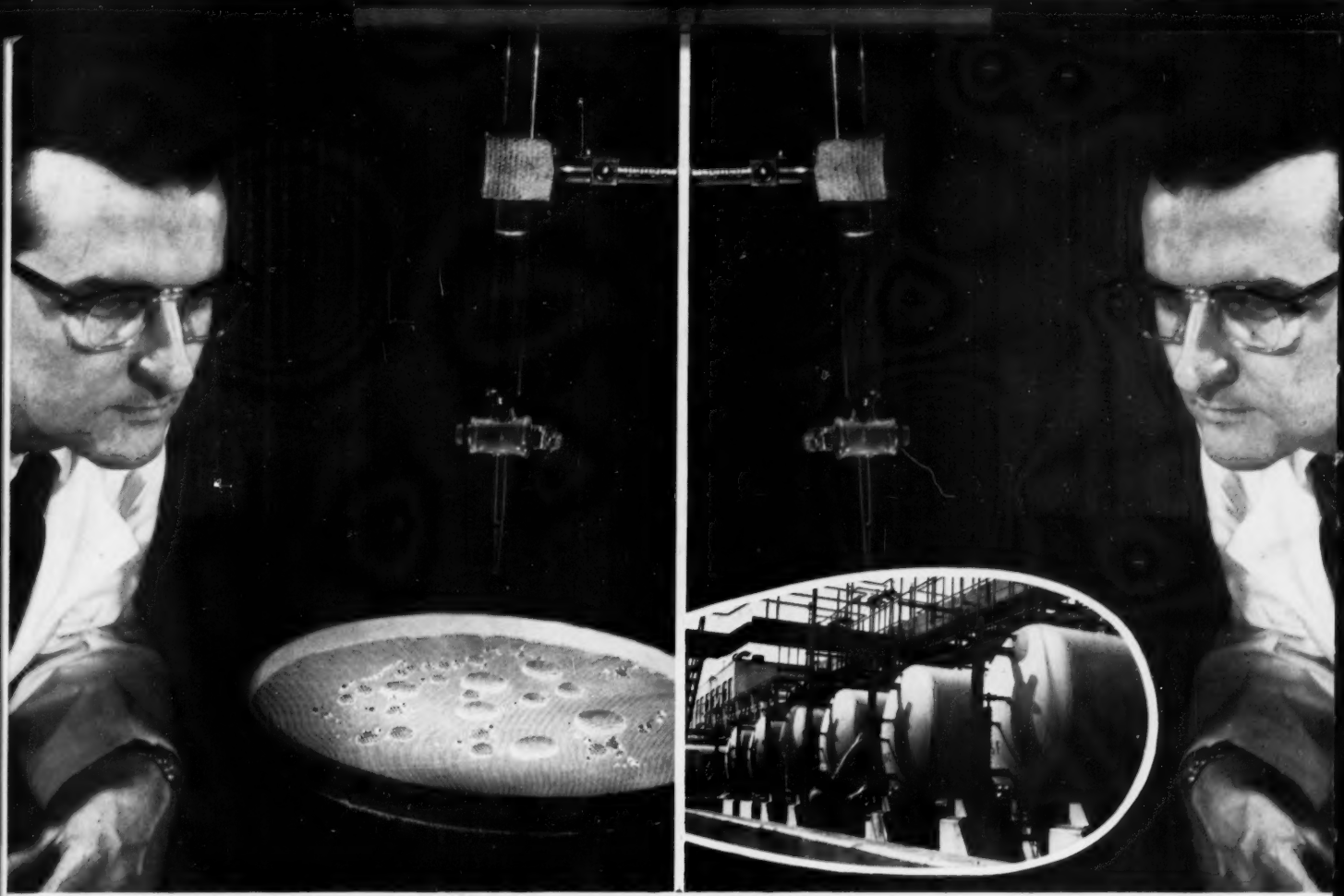

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- Silicone Products
- Electronic Ovens

Research is the life-blood of General Electric. Through the inventions and innovations of its 42 major laboratories, G.E. has become one of the world's fastest-growing and most diversified enterprises, manufacturing over 200,000 different products in a variety of fields. The effectiveness of General Electric's research investment is evidenced by the fact that 70,000 G-E employees now work on products the Company did not make in 1939.

The development of silicone chemical materials is an example of G-E research being translated into a growing new business. From a laboratory curiosity in 1940, silicone research has evolved into a major business at the Waterford, N. Y. plant. Expansion into the silicone field is just one area where research has opened rewarding careers in engineering, manufacturing, and technical marketing for qualified technical personnel.

General Electric's investment in research can mean much to you, the technical student. Continued expansion in new product lines offers boundless opportunities in General Electric's engineering, manufacturing, and technical marketing training programs. To see how you can share in this progress through research, consult your Placement Director or write to Mr. Gregory Ellis, General Electric Company, Section 959-1, Schenectady, New York.

*Progress Is Our Most Important Product*

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